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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: RUNWAY AND TAXIWAY EDGE LIGHTING SYSTEM

1. PURPOSE. This advisory circular describes standards for the design, installation, and maintenance of runway and taxiway edge lighting system.

2. CANCELLATIONS. The following advisory circulars are cancelled.

   a. AC 150/5340-13B, High Intensity Runway Lighting System, dated March 24, 1973.

   b. AC 150/5340-15B, Taxiway Edge Lighting System, dated April 4, 1972.

   c. AC 150/5340-16B, Medium Intensity Runway Lighting System and Visual Approach Slope Indicators for Utility Airports, dated October 26, 1970.

3. RELATED READING MATERIAL. Related reading material is listed in the Bibliography, Appendix 1.

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1. INTRODUCTION. Edge lights are used to outline usable operational areas of airports during periods of darkness and low visibility weather conditions. This circular covers standards for the design and installation of the following systems:

Runways

LIRL - low intensity runway lights
MIRL - medium intensity runway lights
HIRL - high intensity runway lights

Taxiways

LITL - low intensity taxiway lights
MITL - medium intensity taxiway lights

2. SELECTION CONSIDERATIONS. The selection of a particular edge light should be based on the operational need in accordance with the following guidelines:

LIRL - for use on runways at visual flight rule (VFR) airports having no planned approach procedures
* MIRL - for use on VFR runways or runways having a nonprecision instrument flight rule (IFR) procedure for either circling or straight-in approaches *
HIRL - for use on runways having precision IFR approach procedures and for runways utilizing runway visual range (RVR)
LITL - for use on taxiways and aprons where LIRL is used on the runways
MITL - for use on taxiways and aprons on airports using either MIRL or HIRL on the runways

3. RUNWAY EDGE LIGHT CONFIGURATIONS. A runway edge lighting system is a configuration of lights which define the lateral and longitudinal limits of the usable landing area. Two straight lines of lights which are parallel to and equidistant from the runway centerline define the lateral limits. The longitudinal limits of the usable landing area are defined at each end of the area by straight lines of lights called threshold/runway end lights which are installed perpendicular to the lines of runway edge lights. Figure 1 depicts typical configurations.

a. Color of Lights. The runway edge lights emit white (clear) light except that yellow light is substituted for white light on the last 2,000 feet (610 m) of an instrument runway, or one-half the runway length, whichever is less, for indicating the caution zone. The yellow lights are intended for rollout information after landing and are installed on the runway end opposite the landing threshold. They are installed on both ends of a runway only when there is an

instrument approach to both ends. The lights in the caution zone emit yellow light in the direction facing the instrument approach threshold and white light in the opposite direction. The threshold lights emit green light toward the approach area while the runway end lights emit red light toward the runway. These lights are usually combined into one fixture and special lens or filters are used to give the desired light coverages.

b. Location and Spacing. The runway edge lights are located on a line not more than 10 feet (3 m) from the edge of the full strength pavement which is designated for runway use. For runways used by jet aircraft, it is usually advisable to install the lights at the maximum distance to avoid possible damage by jet blasts. For smaller airports a distance of approximately 2 feet (0.6 m) is recommended. The longitudinal spacing of the lights should not exceed 200 feet (61 m) and be located such that a line between light units on opposite sides of the runway is perpendicular to the runway centerline. The lights should be spaced as uniformly as possible with the threshold/runway end lights used as the starting reference points. Where a runway is intersected by other runways or taxiways, a semiflush light, type L-850C as described in AC 150/5345-46, should be installed to maintain the uniform spacing for HIRL's. For MIRL's and LIRL's a single elevated edge light should be installed on the runway side opposite the intersection to avoid gaps in excess of 400 feet (122 m) where the matching of lights on opposite sides of the runway cannot be maintained as illustrated in figure 1.

c. Threshold and Runway End Lights. The combination threshold and runway end lights are located on a line perpendicular to the extended runway centerline not less than 2 (0.6 m) nor more than 10 feet (3 m) outboard from the designated threshold of the runway. The designated threshold is the end of the pavement (surface) useful for aircraft operations. The lights are installed in two groups located symmetrically about the extended runway centerline. For instrument runways each group of lights contains not less than 4 lights; for other runways, not less than 3 lights. In either case, the outermost light in each group is located in line with the runway edge lights. The other lights in each group are located on 10 foot (3 m) centers toward the extended runway centerline.

d. Displaced Threshold. When the threshold is displaced from the * extremity of the runway, the threshold lights are located outboard * from the runway. The innermost light of each group is located in line with the line of runway edge lights, and the remaining lights are located outward, away from the runway, on 10-foot (3 m) centers on a line perpendicular to the runway centerline. As the displaced runway area is usable for specific operations (takeoff, rollout, taxiing), runway edge lights are installed to delineate the outline * of this area as shown in figure 2. For this case, the runway end lights are 360 degree red. *

e. Relocated Threshold. When the threshold is relocated from the extremity of the runway, the threshold and runway end lights may be installed as described in paragraph 3c or 3d. The method described in paragraph 3c is preferred and should be used except in those cases where access to the abandoned area is required or where excessive costs would be encountered.

4. TAXIWAY EDGE LIGHT CONFIGURATIONS. The basic configuration requirements for taxiway edge lighting are shown in figures 4 through 11. All taxiway edge lighting fixtures emit blue light. The light fixtures are located not more than 10 feet (3 m) from the edge of the full strength pavement on each side of the taxiway and spaced longitudinally not more than 200 feet (61 m) apart to define the lateral limits of the taxiing paths. On a straight section the lights on opposite sides of the taxiways are located on a line perpendicular to the taxiway centerline. The longitudinal spacing of the lights is influenced by the physical layout of the taxiways. Closer spacing of the lights should be provided on short taxiway sections, curves, and entrances to taxiways from runways or aprons. In lieu of shorter spacing of the lights, the lights may be supplemented by elevated L-853 reflectors. For low activity airports, elevated L-853 reflectors may be used in lieu of edge lights for outlining taxiing areas. Where used, the reflectors should be spaced the same as taxiway edge lights. When a taxiway extends along the edge of an apron, the lights are located as shown in figure 7. Use of taxiway lights on curved sections at
* small general aviation airports may be reduced as shown in the typical layout of figure 10. Taxiway guidance signs are installed at runway-taxiway intersections to define the throat or entrance into the intersecting taxiing route. Where taxiway signs would interfere with aircraft operations, or at small general utility airports, two taxiway lights spaced as shown in figure 25 may be installed instead of the sign. *

5. SYSTEM DESIGN. Proper planning requires that the design of the lighting system be coordinated with the airport paving and drainage plans. The drainage design may influence the location of cable ducts and trenches. Also, adequate conduits and ducts should be provided prior to paving operations since they are very expensive to install under existing paved areas.

a. System Design Options. Several design options may be utilized as follows:

(1) Base mounted light units (see paragraph 5b) may be used on the HIRL, MIRL, or MITL.

(2) Stake mounted light units (see paragraph 5b) may be used on the HIRL, MIRL, LIRL, MITL, or LITL.

(3) Series power circuits (see paragraph 5c) may be used for the HIRL, MIRL, or MITL.

* (4) Parallel power circuits (see paragraph 5c) may be used for the MIRL, LIRL, MITL, or LITL.

(5) Select the required type of threshold/runway end light for the MIRL (see paragraph 6a). *

(6) Several control methods are available (see paragraph 5g).

(7) The use of a counterpoise wire is optional (see paragraph 6h(4).

b. Base Mounted or Stake Mounted Fixtures. The stake mounted method, in comparison to the base mounted method, costs less to install. Since the transformers, cables, and connectors are designed for direct earth burial, the underground system should provide years of fault-free service if properly installed. The base mounted installation is advantageous from a maintenance standpoint and provides added protection for the equipment. The stake mounted method can be used for either series on parallel circuits whereas the base mounted method is normally used only with series circuits.

c. Series or Parallel Circuits. The advantages of the series circuit are:

(1) Uniform lamp brightness - all lamps receive the same operating current.

(2) Lower costs for longer runways - generally those over 4,000 feet in length.

The advantage of the parallel circuit is lower costs for shorter runways - generally all those of 4,000 feet or less.

d. RVR Connections. Where runway visual range (RVR) equipment is to be installed, provide two No. 12 AWG wires for 120-volt control, or two No. 19 wires if 48-volt control is used, between the control tower and the vault. The ends of the wires are taped or sealed, until connections are made, to prevent the entrance of moisture. The wires in the vault connect to an interface unit provided with the RVR equipment. The wires in the tower connect to RVR equipment. All connections are made by personnel responsible for the RVR in accordance with instructions provided with the system.

* e. Use of Reflectors. For low activity general aviation airports, taxiway lights can be augmented or replaced with L-853 elevated edge reflectors as described in AC 150/5345-39. *

f. Brightness Steps.

(1) The HIRL has five brightness steps as follows:

Percent Brightness	Lamp Current (amps)
100	6.6
25	5.2
5	4.1
1.2	3.4
0.15	2.8

(2) The MIRL has three brightness steps as follows:

Percent Brightness	Series Systems Lamp Current (amps)	Parallel Systems Lamp Voltage (volts)
100	6.6	120
30	5.5	85
10	4.8	60

(3) The LIRL and LITL have only one brightness step. The MITL has three brightness steps, as for the MIRL, when installed using a series circuit and powered by an L-811 or L-812 regulator. When the MITL is installed using a parallel circuit, only one brightness step is required although it may be desirable to provide equivalent brightness steps as obtained with the series circuit. This may be accomplished by use of a variac, autotransformer, or other means.

g. Control Methods. Several control methods may be used including direct control or remote control. Remote control may be accomplished by use of land lines or by radio control using L-854 equipment as specified in AC 150/5340-14. Remote control is strongly recommended at any location served by a control tower, flight service station, or other manned offices where operation of the facility could be accomplished. Local control may be done by direct switching at the site or by using automatic control such as a photoelectric control device or astronomic time switch with provisions for switching from automatic to manual control. Typical applications of direct control are shown in figures 16 and 20. Figures 17, 18, and 21(a) show typical applications for remote control of regulators.

(1) Remote Control (120 Volts AC). Where the distance between the remote control panel and the vault is not great enough to cause an excessive voltage drop in the control leads, use the standard control panel switches to operate the control relays directly. Operating relays supplying power to the regulators must have coils rated for 120 volts AC. Use No. 12 AWG control cable to connect the control panel to the power supply equipment in the vault. Calculate the maximum permissible

separation between the control point and the vault by determining the control circuit line loss. Typical relay characteristics are shown in the following table:

COIL	REGULATOR SIZE	OPERATING VOLTS	IN-RUSH CURRENT	PULL-IN VOLTS	HOLDING CURRENT	DROP-OUT VOLTS
PRIMARY CONTACTOR	4KW	120	1.4	99	0.22	77
BRIGHTNESS RELAY	4KW	120	0.92	99	0.20	77
PRIMARY CONTACTOR	7½KW	120	5.0	99	0.78	77
BRIGHTNESS RELAY	7½KW	120	0.93	99	0.38	77
AUXILIARY RELAY 5000 OHM	SPST	120		95-75	0.024	70
PRIMARY AND BRIGHTNESS RELAYS	TYPICAL L-828	120	0.286	85	0.087	54

(2) Auxiliary Relay (120 Volts AC). Special low-burden pilot auxiliary relays, having proper coil resistance to reduce control current, may be used to obtain additional separation distance with 120-volt AC control circuits. It may be advantageous to use these relays to expand existing 120-volt AC control systems. See figure 21(b) for typical applications with an L-812 regulator.

(3) Remote Control (48 Volts DC). An alternate method used where the distance between the control panel and the vault would cause excessive control voltage drop is a low voltage (48-volt DC) control system. In such a system, sensitive pilot relays are activated by the remote control panel switches and, in turn, control the regulator relays through their contacts. Normally, a 25 pair, No. 19 AWG telephone cable can be used to connect the control panel to the pilot relays. For typical application details, see Advisory Circular 150/5345-3 and figure 21(c) of this circular.

6. EQUIPMENT AND MATERIALS. Equipment and materials used which are not specified herein shall be suitable for the intended use. Electrical equipment such as distribution transformers, oil switches, relays, etc., shall bear the Underwriters Label.

a. Light Fixtures. Light fixtures shall conform to AC 150/5345-48 as follows:

System	Light Fixture Type	
	Edge	Threshold
HIRL	L-862 (1)	L-862
MIRL	L-861	L-861SE L-861E (2)
LIRL	L-860	L-860E
MITL	L-861T	
LITL	L-860T	

(1) Use type L-850-C light fixtures conforming to AC 150/5345-46 where required for semiflush installations.

(2) For runways served by either a visual approach slope indicator (VASI), runway end identifier lights (REIL), medium approach light system (MALS), or lead-in lighting system (LDIN), the type L-861E light fixture may be used in lieu of the type L-861SE light fixture.

b. Isolation Transformers. Isolation transformers, for use in series circuits, shall be type L-830 conforming to AC 150/5345-47, and shall be of the proper rating.

c. Cable Connectors. Cable connectors for use in series circuits shall be type L-823 conforming to AC 150/5345-26, figure 14. For parallel circuits, specify connectors in accordance with item L-108, paragraph 108-2.4 of AC 150/5370-10 or equal.

d. Light Base and Transformer Housings. Light base and transformer housings shall be type L-857 conforming to AC 150/5345-42. A 12-inch (30 cm), type I is used for elevated light fixtures and a 15-inch (38 cm), type II is used for semiflush light fixtures.

e. Regulators. Regulators for use with series circuits shall conform to AC 150/5345-10, type L-828 for the HIRL and AC 150/5345-18, type L-811 or AC 150/5345-11, type L-812 for the MIRL. The L-811 regulator is directly controlled whereas the L-812 and L-828 regulators are remotely controlled. The L-812 regulator is generally used for MITL series circuits.

f. Control Panel. The remote control panel conforms to the requirements of Advisory Circular 150/5345-3. The panel consists of a top panel plate and a housing. In addition, it has toggle switches, terminal boards, and brightness controls, as required. The number of components to be mounted on the panel should be specified when the equipment is ordered.

g. Auxiliary Relay Cabinet. An auxiliary relay cabinet assembly conforming to Advisory Circular 150/5345-13 is required when 48-volt DC control is used. The assembly consists of an enclosure containing a DC power supply, control circuit protection, and 20 pilot relays.

h. Cable.

(1) Series Primary Circuit. Select specification L-824 cable in accordance with AC 150/5345-7. No. 8 AWG, 5,000-volt cable will satisfy most operational requirements. No. 6 AWG, 5,000-volt cable should be used for long "homeruns" or with 20 ampere circuits.

(2) Parallel Primary Circuit. Select specification L-824, 600-volt single or double conductor cable in accordance with AC 150/5345-7 or select 600 volt, stranded copper, single or double conductor cable, suitable for direct earth burial as specified in the National Electric Code and/or controlling local codes. Specify AWG wire sizes that will provide the required lamp voltage within 5 percent.

(3) Control Circuits. For control circuits using alternating current (AC), use control cable containing No. 12 AWG wire conforming to Advisory Circular 150/5345-7. For direct current (DC) control circuits, use cable containing No. 19 AWG wires that conform to the requirements of Rural Electrification Administration Bulletin 345-14 or 345-67.

(4) Counterpoise Wire. If required, select counterpoise wire, No. 8 AWG, conforming to the requirements of paragraph 108-2.2 or 108-2.3 of AC 150/5370-10.

i. Duct and Conduit. Duct and/or conduit shall conform to the requirements of paragraph 110-2 of AC 150/5370-10.

j. Concrete. Concrete shall conform to the requirements of item P-610 of AC 150/5370-10.

k. Tape. Plastic electrical insulating tape is the type specified in item L-108 of AC 150/5370-10.

l. Vaults. Utilize design considerations for vaults contained in item L-109 of Advisory Circular 150/5370-10. Provide at least 2 square feet (0.2 sq. m.) net vent area per 100 KVA installed transformer capacity in the vault where the 24-hour average ambient temperature does not exceed 86°F. If the average ambient temperature exceeds 86°F., auxiliary means should be provided for removing excess heat. Install vault equipment, conduit, cables, grounds, and supports necessary to insure a complete and operable electrical distribution center for lighting systems. An up-to-date "as constructed" lighting plan should be kept available in the vault. When required, provide an emergency power supply and transfer switch, see Advisory Circular 150/5340-17. Install and mount the equipment to comply with the requirements of the National Electric Code and local code agencies having jurisdiction.

7. INSTALLATION. The system shall be installed in accordance with the National Electrical Code and/or local code requirements.

a. Light Base and Transformer Housing for Elevated Light Fixtures. The light base shall be installed on undisturbed soil as shown in figure 13. If the soil is unsuitable, then an adequate depth of soil should be removed and replaced with compacted acceptable material. The cable entrance hubs are oriented in the proper direction. Level the light base so that the mounting flange surface is approximately 1 inch above the finished grade. With the base properly oriented and held at the proper elevation, place approximately 4 inches (10 cm) of concrete backfill around the outside of the base. The top of the concrete is sloped away from the flange portion of the base so the sloped outer edges of the concrete are at surface grade. If concrete backfill is omitted, select earth backfill shall be compacted to maintain proper orientation and elevation of the base. In closed duct systems installed in soil conditions of good drainage, use light bases having a drain hole to prevent water accumulation.

b. Light Base and Transformer Housing for Semiflush Light Fixtures. The base is supported in the leaveout or excavated area in a position as shown in figure 23. Orient the base so that the cable entrance hubs on the base are properly aligned and so that the semiflush light fixture will be properly aligned, when installed, prior to placing the concrete backfill. When installed in bituminous pavement, leave the concrete backfill 3-4 inches (8-10 cm) low to allow completing the backfill with bituminous material after the concrete has cured.

c. Stake (Angle Iron) Mounting. Install the stake in a 6-inch (15 cm) diameter hole at a depth of 30 inches (76 cm) as shown in figure 13. Do not install stake by driving. Make electrical connections and backfill around the stake with thoroughly compacted earth passing a 1-inch (2.54 cm) sieve. Where required due to unstable soil conditions, backfill with concrete. Install the top of the stake even with, or not more than 1/2 inch (1.3 cm) above the finished grade and maintain within 1 degree of the vertical. In areas where frost may cause heaving, anchor the stake with concrete and use a permeable backfill material such as sand around the buried electrical components and then cover the top surface with an impervious material to reduce moisture penetration.

d. Light Fixtures - General. The light fixtures are supplied unassembled and consist of an optical system, lamp, connecting leads, and a mounting assembly. The installer will assemble, connect to mounting, level, and adjust the light fixture in accordance with the manufacturer's instructions. Care should be taken that the lamp specified by the manufacturer, for the particular use of the light fixture, is installed. The light fixtures are leveled and aligned, where appro-
* priate, within 1 degree. The standard height of the top of the elevated light fixture is 14 inches (35 cm) above the finished grade. In areas where the mean annual total snowfall exceeds 2 feet (0.6 m), this standard elevation may be increased as illustrated in figure 24. In order to facilitate maintenance of light fixtures, it is recommended that identification numbers be assigned and installed by one of the following or similar methods. *

(1) Stencil numbers with black paint on the runway side of the base plate. The minimum height of the numbers is 2 inches (5 cm).

(2) Attach a noncorrosive disc with permanent numbers to the fixture. The minimum height of the numbers is 2 inches (5 cm).

(3) Impress numbers on a visible portion of the concrete backfill. The minimum height of the numbers is 3 inches (7.6 cm).

e. Base Mounted Light Fixtures. This type of installation is normally used only with series circuits to house the isolation transformer and accommodate a closed duct system. Prior to mounting the light fixture on the base, an L-823 connector kit is installed on the primary power cable ends and the appropriate L-830 isolation transformer is installed. These transformers serve as a means for isolating the light unit from the high voltage primary of the series circuit. Wrap the connector joints in the primary circuit with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (3.8 cm) on each side of the joint. Typical fixture and duct details are shown in figures 12 and 13. Plug the light disconnecting plug into the transformer secondary receptacle. Do not tape this connection.

f. Stake Mounted Light Fixtures. For series circuits, make connections and transformer installation as detailed in the previous paragraph. Bury the transformer primary cable connectors at least 10 inches (25 cm) deep and adjacent to the stake as shown in figure 13. By burying the components in like locations at each stake, maintenance of the underground system is facilitated. When installed in a location where the frost line depth exceeds the minimum cable installation depth, as specififed in AC 150/5370-10, item L-108, increase to a maximum of 2 feet (0.6 m) in depth the installation of the cable, transformers, and connectors. Do not attach cable connectors to the stakes. Install primary cable connectors, splices, and transformers at the same depth and in the same horizontal plane as the primary cable with adequate slack provided. The radius of cable bends should not be less than 10 inches (25 cm). Place the secondary leads from the transformer to the lamp socket in a loose spiral with excess slack at the bottom.

g. Shielding Taxiway Lights. In order to shield undesirable blue light to landing pilots or lessen the "sea-of-blue" effect, metal shields or hoods are available, as an option, from the lamp manufacturers. See figure 22 for suggested orientation. Orient fixtures with masked lamps by rotating the fixture on its mounting for proper light pattern before securing in place. Use of brightness control is desirable to adjust the blue light level to match visibility conditions. This feature also prolongs lamp life. Proper control circuiting will also help to eliminate the "sea-of-blue" effect by providing lighting only where it is needed.

h. Direct Burial Cable. Install all power or control cables by direct burial in trenches except where the routing is through paved or stabilized areas. Seal cable ends during construction to prevent the entrance of moisture. When using L-857 light bases in a system, provide at least 2 feet of slack cable to permit connections of the primary cable and the isolation transformer primary leads to be made above ground. Trenching, installation of cable, backfilling trenches, and the installation of cable markers is to conform to paragraph 108 of AC 150/5370-10. Cable plowing is allowed where suitable soil conditions exist.

i. Cable in Duct and/or Conduit. Install all power or control cables in ducts and conduits to conform to paragraph 108-3.2 of AC 150/5370-10. Provide slack cable for connections as stated in paragraph 7h. Install the duct and/or conduit conforming to the requirements of paragraph 110-3 of Advisory Circular 150/5370-10.

j. Installing Duct or Conduit Under Paved Surfaces. Provide a reasonable number of spare ducts or conduits in each bank for maintenance and future expansion of facilities. Avoid routing ducts or conduits through areas which may have to be excavated.

Where ducts are in tiers, use the lowest ducts to receive cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and interferences are avoided.

k. Counterpoise. If required, install counterpoise wire for lightning protection in the same trench 4 inches above the insulated cable it is to protect as specified in paragraph 108-3.9 of AC 150/5370-10.

l. Splices. Make splices on underground cables to conform to paragraph 108-3.8 of AC 150/5370-10. No splices are to be in ducts, conduits, or in circuits between light fixtures unless housed in an approved manhole, handhole,or light base and transformer housing. Where crimp connectors or field attached plug-in connectors conforming to AC 150/5345-26 are employed, use crimping tools of the type that must be fully closed before they can be released and designed for the specific type connector to assure crimps or detents meeting the necessary tensile strength.

8. INSPECTION.

a. Inspect each light fixture to determine that it is installed correctly, at the proper height, in line with the other fixtures, level,and properly oriented.

b. Check the light fixtures with asymmetrical lenses to determine that they are properly oriented with respect to the runway longitudinal sides and the threshold. Check all lights for alignment.

c. Check identification number for each light unit to determine that the number at the installation is as assigned in the plans.

d. Check equipment covered by Federal Aviation Administration specifications to determine if the manufacturers have supplied approved equipment. The equipment is also checked for general conformance with specification requirements.

e. Inspect all cables, wiring, and splices to obtain assurance that the installation is in accordance with Advisory Circular 150/5370-10, National Electrical Code, and local codes. Inspect and test insulation resistance of underground cables before backfilling.

f. Check all ducts and duct markers to determine that the installation is in accordance with Advisory Circular 150/5370-10. Inspect underground ducts before backfill is made.

g. Check the input voltage at the power and control circuits to determine that the voltage is within limits required for proper equipment operation. Select the proper voltage tap on equipment where taps are provided.

h. Check fuses and circuit breakers to determine if they are of the proper rating.

i. Check base plate for damage during installation and refinish according to manufacturer's instructions.

j. Check the current or voltage at the lamps to determine if the regulator current or supply voltage is within specified tolerance. If a current or voltage exceeds rated values the lamp life will be reduced.

9. TESTS.

a. Test the installation by operating the system continously for at least 1/2 hour. In addition, operate each control not less than 10 times.

b. Test the completed circuits in accordance with the requirements of item L-108 of Advisory Circular 150/5370-10. This includes testing the insulation resistance of ungrounded circuit conductors with a 500-volt megger type tester. Minimum acceptable resistance to ground is 50 megohms. Testing of multiple circuits will require removal of all lamps.

c. Test the vault equipment for proper grounding. This test includes a check to determine that the resistance to ground on any part of the grounding system will not exceed 10 ohms.

d. Subject the regulators and other applicable equipment to performance tests specified in the manufacturer's instructions for the initial installation.

10. MAINTENANCE.

a. General. A maintenance program is necessary to insure proper operation and dependable service from the equipment. Although the system may be of the highest order of reliability, its effectiveness will soon depreciate unless it is properly maintained.

b. Operational Check. Make a daily operational check of all lighting fixtures. If any lamps are out, the locations of the fixtures are recorded and the lamps replaced at a time when the fixture is deenergized. The lamp socket and electrical contacts should be checked before replacing the lamp and reenergizing the system.

c. Lens. Check the light fixture lens periodically to determine if the glassware has been cracked or pitted beyond use by debris. Clean the lens periodically to permit the units to operate at maximum efficiency. The regularity and type of cleaning will be dictated by local conditions. Check lens for level and alignment.

d. Snow Removal. Remove snow from around the lighting fixtures as soon as possible after a snowfall to prevent obscuring the emitted light. Take care to prevent damage to light fixture during snow removal.

e. Bases. The base mounted fixture installations are designed to exclude both ground and surface water from entering the base. For varying reasons, water sometimes enters and can become a serious problem, particularly where temperatures below freezing are encountered. To prevent possible damage, establish a regular maintenance schedule to inspect each base for the presence of water especially during the fall and winter months. A regular schedule for tightening cover holddown bolts is recommended. If any of the bases contain water, remove the water and replace gasket if necessary. The use of a base with a drain hole in the bottom may eliminate this problem in some areas.

f. Grass. Establish a regular schedule for removing grass or other vegetation near the lighting fixtures.

g. Cable. Check the initial condition of cables with a 500-volt insulation resistance tester. Make a record of the initial resistance values. Check the condition of the system periodically by comparing monthly resistance readings with the initial and subsequent values. In an acceptable system, the initial resistance values are not less than 50 megohms. If the monthly resistance checks reveal progressive deterioration or faults, take corrective steps promptly.

(1) Perform monthly insulation resistance checks by deenergizing the regulator or power, disconnecting the cable leads at the regulator or power source, and connecting one lead of the insulation resistance tester to the lighting cable and the other lead to a proven ground.

(2) Advise maintenance personnel that high open circuit voltage will be present when the secondary of an energized series lighting regulator is opened. Therefore, positive means should be taken to prevent energizing the regulator while maintenance is being undertaken on the circuit.

h. Spare Parts. Stock adequate spare parts for maintenance purposes. See individual manufacturer's instructions for recommended items. At least 10 percent spare lamps should be available with the initial installation.

i. Vault. Keep the vault clean and uncluttered to prevent dirt from accumulating in control compartments and to allow equipment to be

accessible at all times. Make warning signs legible and mount them in conspicuous locations. An "as constructed" electrical diagram of the lighting system should be displayed in the vault. Protect the diagram with glass, plastic,or other transparent material. Modifications or extensions made in connection with the above plans should be kept up to date by the chief electrician. A maintenance instruction book and descriptive parts list for each piece of installed equipment should be available.

j. Constant Current Regulators. Monthly measurements for rated output current should be made of each regulator. Change of input transformer taps or other regulator adjustments should be made to provide rated output current so proper lamp brightness can be maintained.

APPENDIX 1. BIBLIOGRAPHY

1. Advisory Circular (AC) 00-2, Advisory Circular Checklist and Status of Federal Aviation Regulations, updated triannually, contains the listing of all current issuances of advisory circulars and changes thereto. It explains the circular numbering system and gives instructions for ordering advisory circulars that are for sale as well as those distributed free of charge.

   a. The following free advisory circulars may be obtained from the Department of Transportation, Subsequent Distribution Unit, M-494.3, Washington, D.C. 20590.

      (1) Advisory Circular 00-2, Federal Register, Advisory Circular Checklist and Status of Federal Aviation Regulations.

      (2) AC 150/5300-4, Utility Airports - Air Access to National Transportation.

      (3) AC 150/5340-14, Economy Approach Lighting Aids.

      (4) AC 150/5340-17, Standby Power for Non-FAA Airport Lighting Systems.

      (5) AC 150/5345-1, Approved Airport Lighting Equipment.

      (6) AC 150/5345-3, Specification for L-821 Airport Lighting Panel for Remote Control of Airport Lighting.

      (7) AC 150/5345-4, Specification for L-829 Internally Lighted Airport Taxi Guidance Sign.

      (8) AC 150/5345-7, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits.

      (9) AC 150/5345-10, Specification for L-828 Constant Current Regulators.

      (10) AC 150/5345-11, Specification for L-812 Static Indoor Type Constant Current Regulator Assembly; 4KW and 7½ KW; With Brightness Control for Remote Operation.

      (11) AC 150/5345-13, Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.

      (12) AC 150/5345-18, Specification for L-811 Static Indoor Type Constant Current Regulator Assembly, 4KW; With Brightness Control and Runway Selection for Direct Operation.

(13) AC 150/5345-26, Specification for L-823 Plug and Receptacle, Cable Connectors.

(14) AC 150/5345-39, FAA Specification L-853, Runway and Taxiway Retroreflective Markers.

(15) AC 150/5345-42, FAA Specification L-857, Airport Light Bases, Transformer Housings, and Junction Boxes.

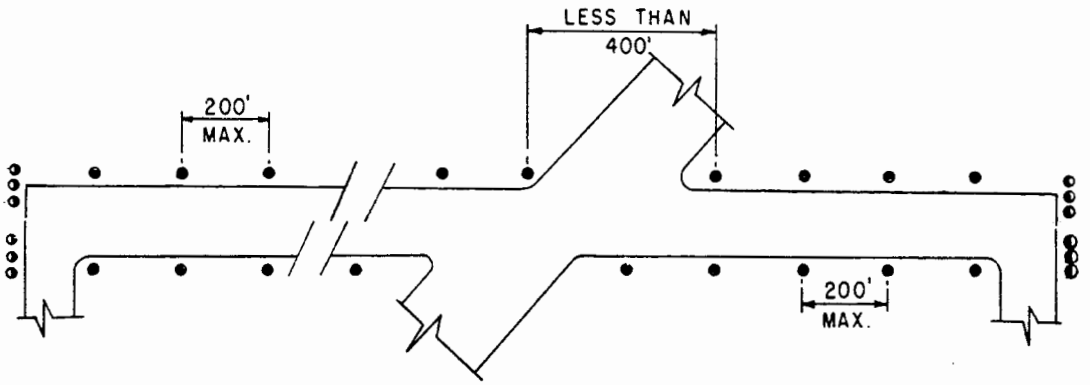
(16) AC 150/5345-46, Specification for Semiflush Airport Lights.

(17) AC 150/5345-47, Isolation Transformers for Airport Lighting Systems.

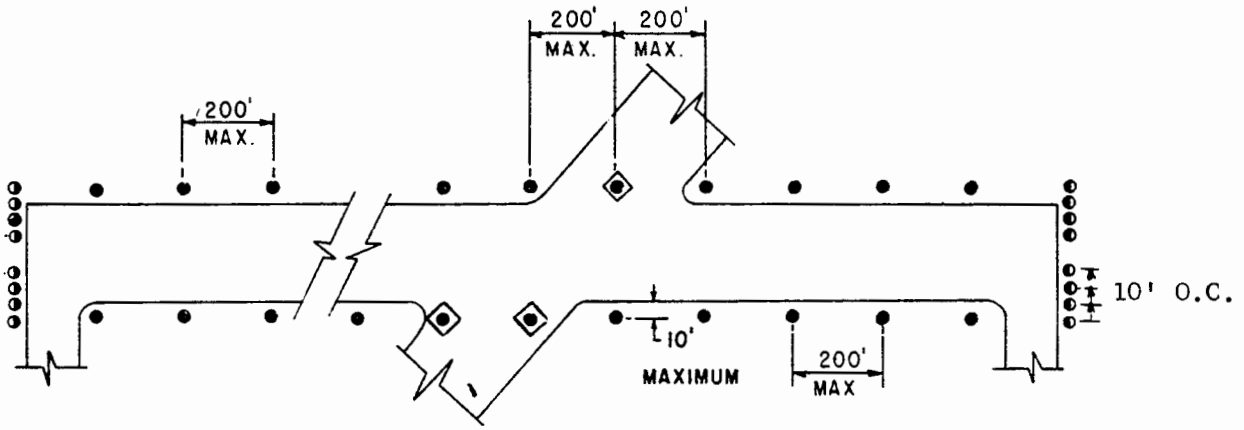
(18) AC 150/5345-48, Specification for Runway and Taxiway Edge Lights.

b. Advisory Circular 150/5370-10, Standards for Specifying Construction of Airports, may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402.

c. Obtain copies of Rural Electrification Administration (REA) Bulletin 345-67 or 345-14, REA Specification for Fully Color-Coded, Polyethylene Insulated, Double Polyethylene-Jacketed Telephone Cable for Direct Burial, from the U. S. Department of Agriculture, Rural Electrification Administration, Information Services Division, Washington, D.C. 20250.



APPLICATION OF SINGLE ELEVATED LIGHTS



APPLICATION OF SINGLE ELEVATED LIGHTS AND SEMIFLUSH LIGHTS

LEGEND:

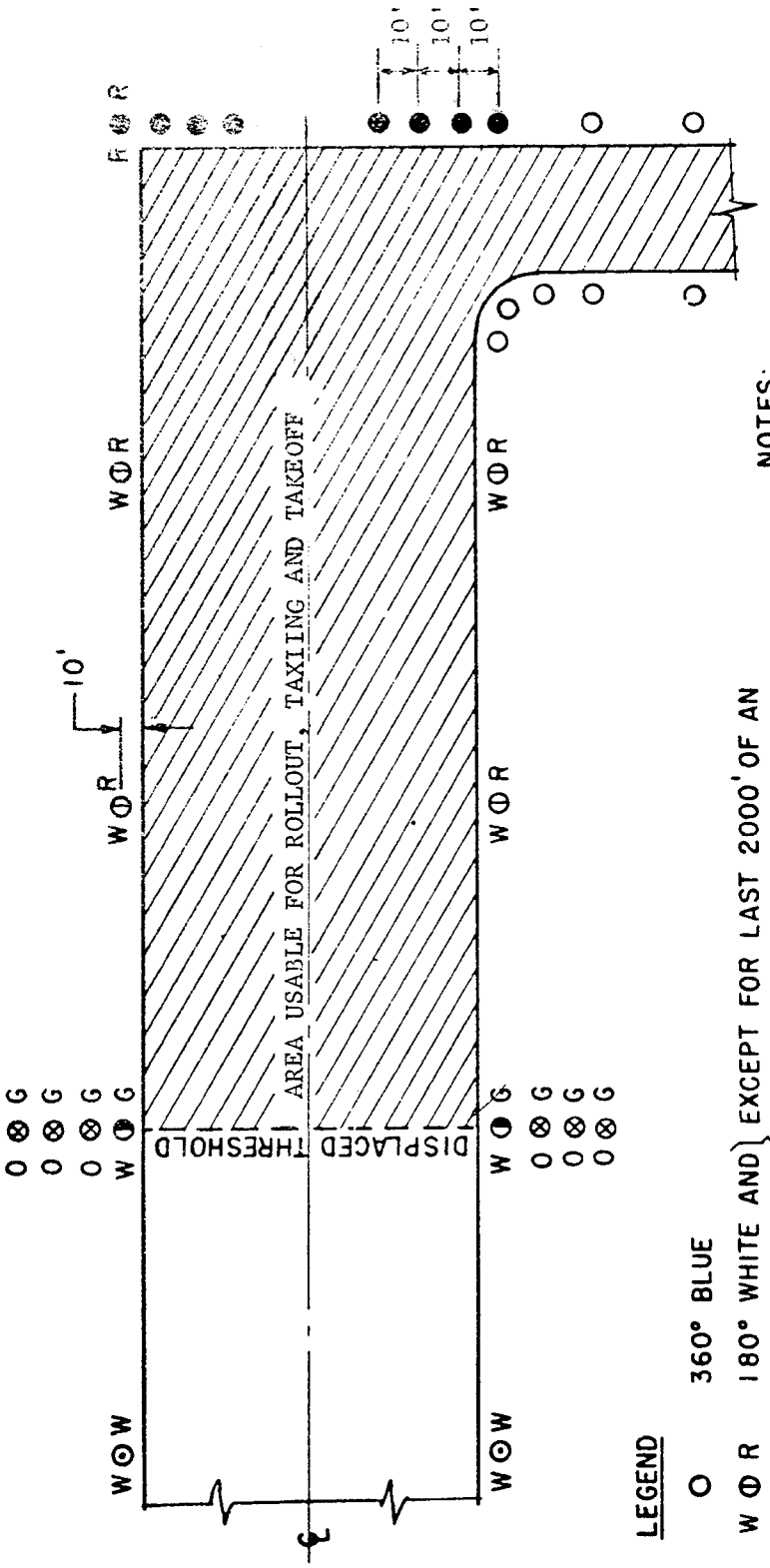
●--- 360° WHITE, EXCEPT FOR THE LAST 2,000' OF THE INSTRUMENT RUNWAY

R●G--RED 180° AND GREEN 180°

◈-- SEMIFLUSH FIXTURE BIDIRECTIONAL

NOTE: SIX THRESHOLD LIGHTS USED ON NON-INSTRUMENT RUNWAYS
EIGHT THRESHOLD LIGHTS USED ON INSTRUMENT RUNWAYS

FIGURE 1. RUNWAY AND THRESHOLD LIGHTING CONFIGURATIONS



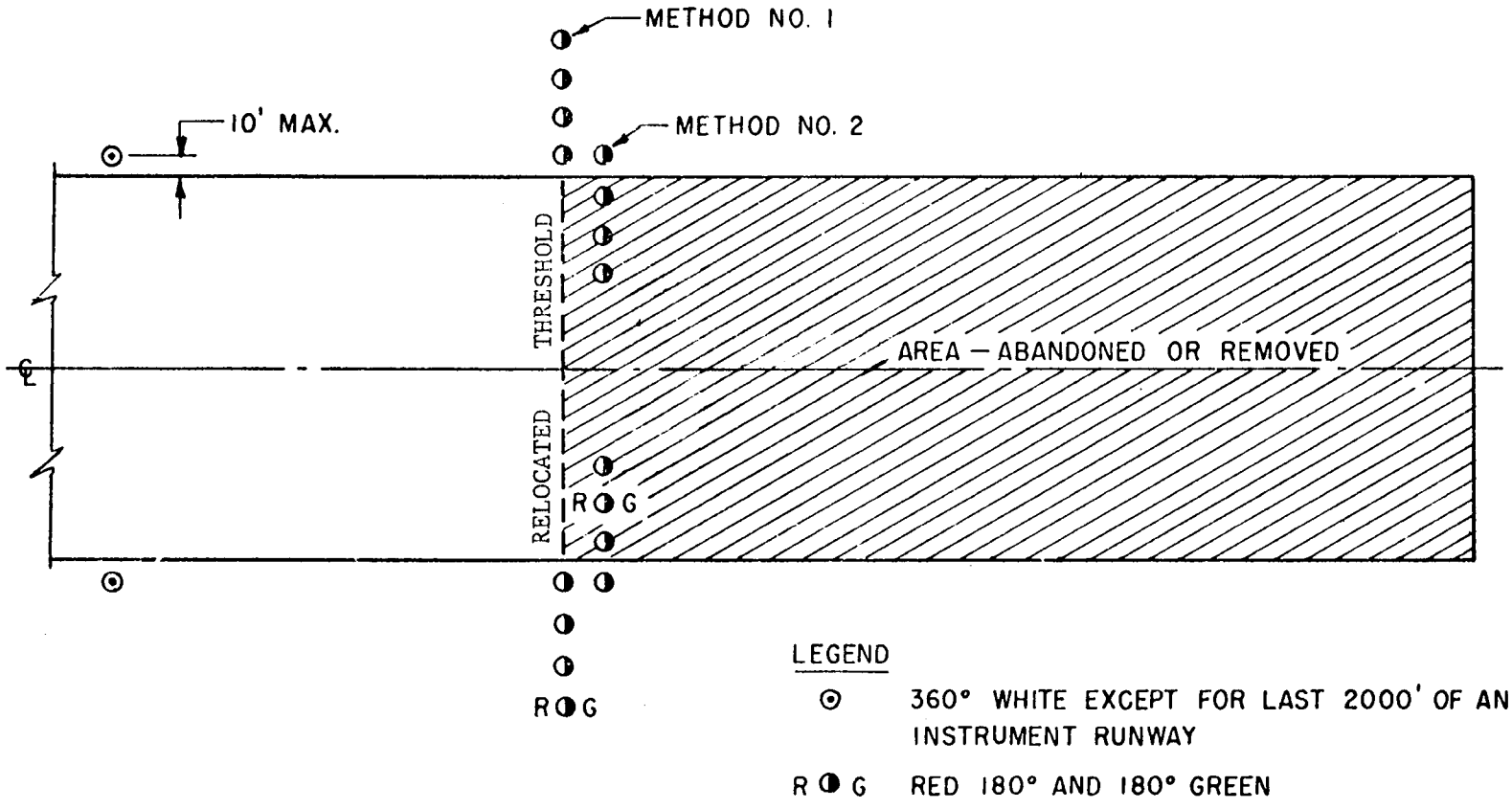
LEGEND

O	360° BLUE	
W ⊕ R	180° WHITE AND 180° RED	EXCEPT FOR LAST 2000' OF AN INSTRUMENT RUNWAY
⊙	360° WHITE	EXCEPT FOR LAST 2000' OF AN INSTRUMENT RUNWAY
●	360° RED	
O ⊗ G	180° OBSCURED AND 180° GREEN	
W ◑ G	180° WHITE AND 180° GREEN	EXCEPT FOR LAST 2000' OF AN INSTRUMENT RUNWAY

NOTES:

1. SPACING OF RUNWAY LIGHTS SHALL BE IN ACCORDANCE WITH FIGURE 1.

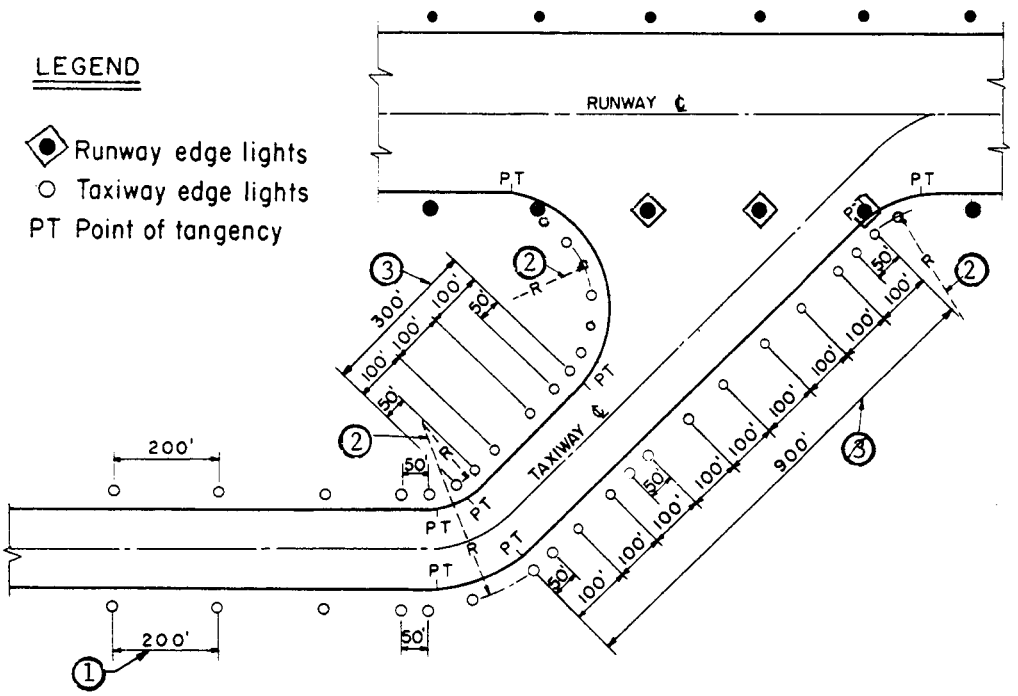
FIGURE 2. DISPLACED THRESHOLD



NOTES:

1. METHOD NO. 1 FOR ABANDONED AREA WHERE PAVED AREA IS LEFT IN PLACE.
2. METHOD NO. 2 FOR ABANDONED AREA WHERE PAVED AREA IS REMOVED.
3. SPACING OF RUNWAY LIGHTS SHALL BE IN ACCORDANCE WITH PARA. 3.
4. ALL THRESHOLD LIGHTS ARE SPACED ON 10' CENTERS.

FIGURE 3. RELOCATED THRESHOLD - UNUSABLE AREA ABANDONED OR REMOVED



NOTES:

(1) On long straight sections of taxiways, the longitudinal spacing of lights may approach but not exceed 200 feet.

(2) Spacing of lights on taxiway curved edges is as shown in Figure 9.

(3) Spacing of lights on short straight sections is as shown in Figures 5,6,7 & 8.

FIGURE 4. TYPICAL TAXIWAY LIGHTING CONFIGURATION.
(high density traffic airports)

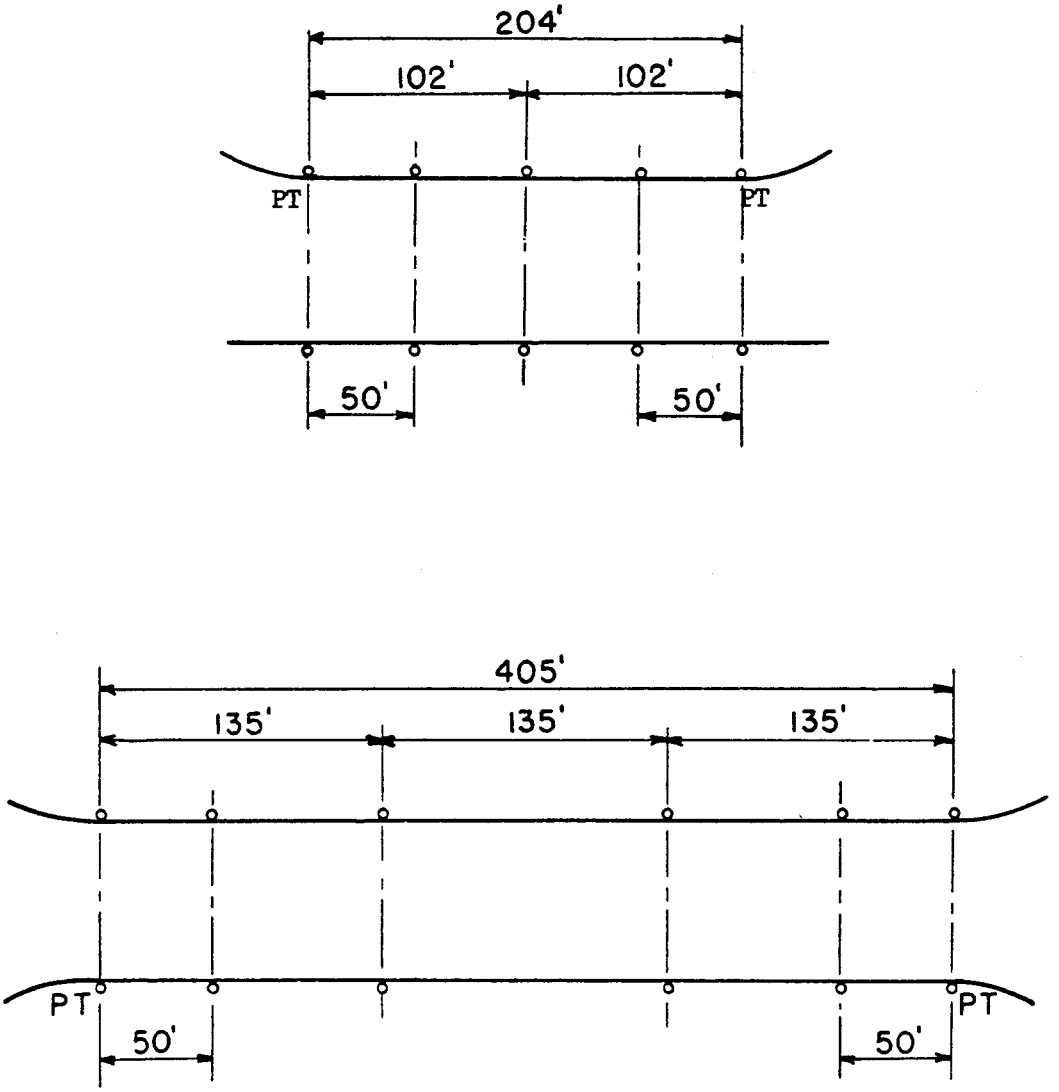


FIGURE 5. TYPICAL STRAIGHT TAXIWAY SECTIONS - MORE THAN 200 FEET

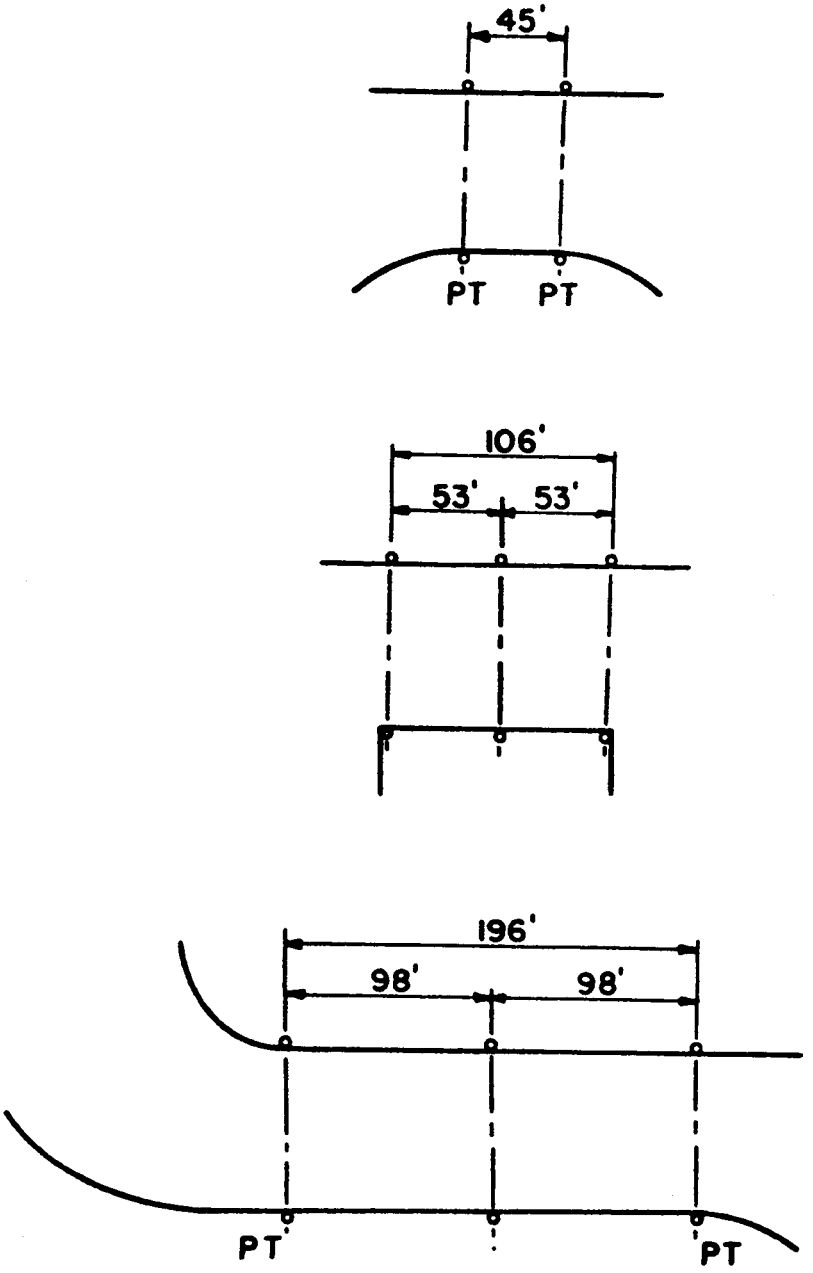


FIGURE 6. TYPICAL STRAIGHT TAXIWAY SECTIONS - LESS THAN 200 FEET

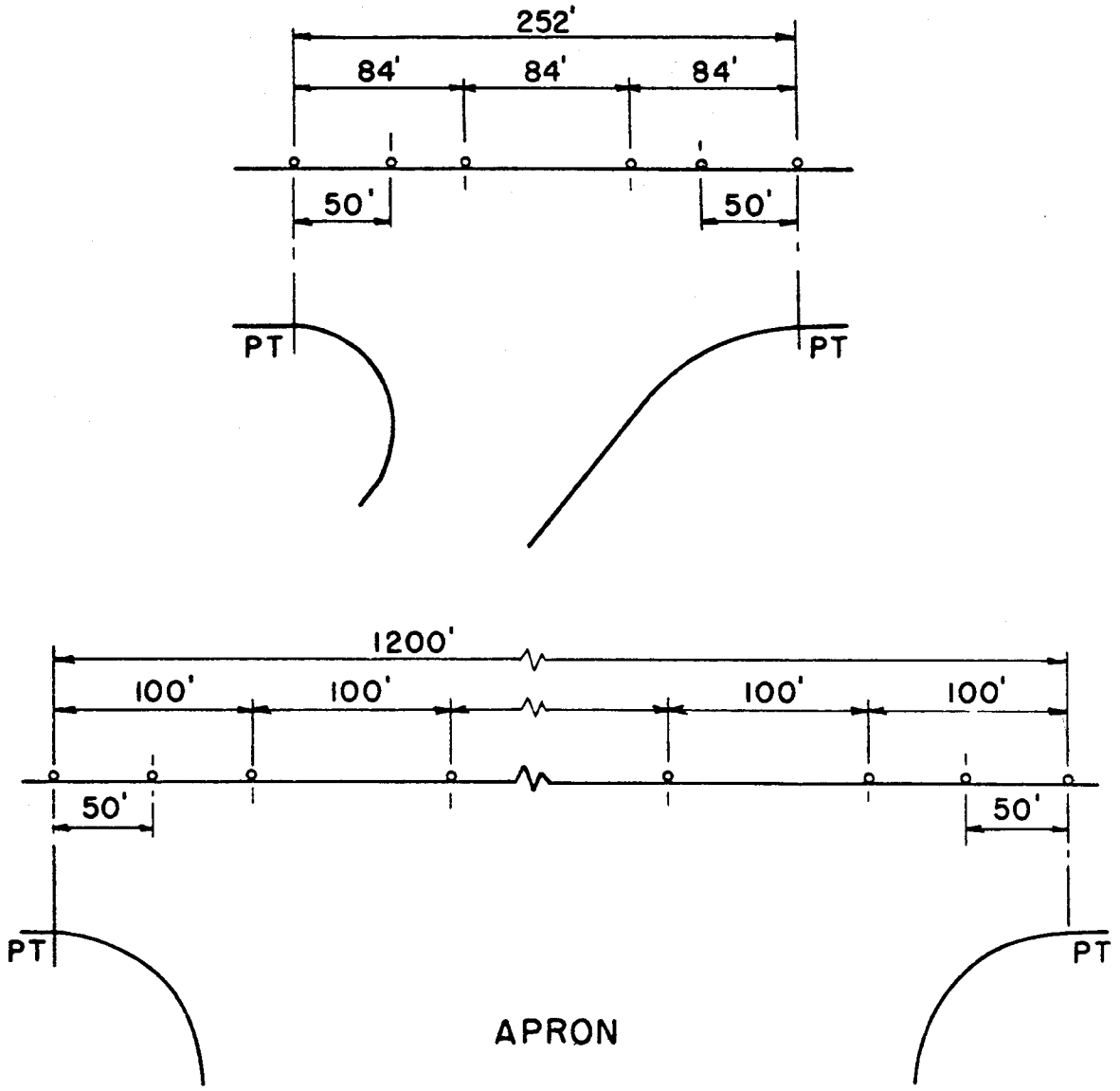


FIGURE 7. TYPICAL SINGLE STRAIGHT TAXIWAY EDGES - MORE THAN 200 FEET

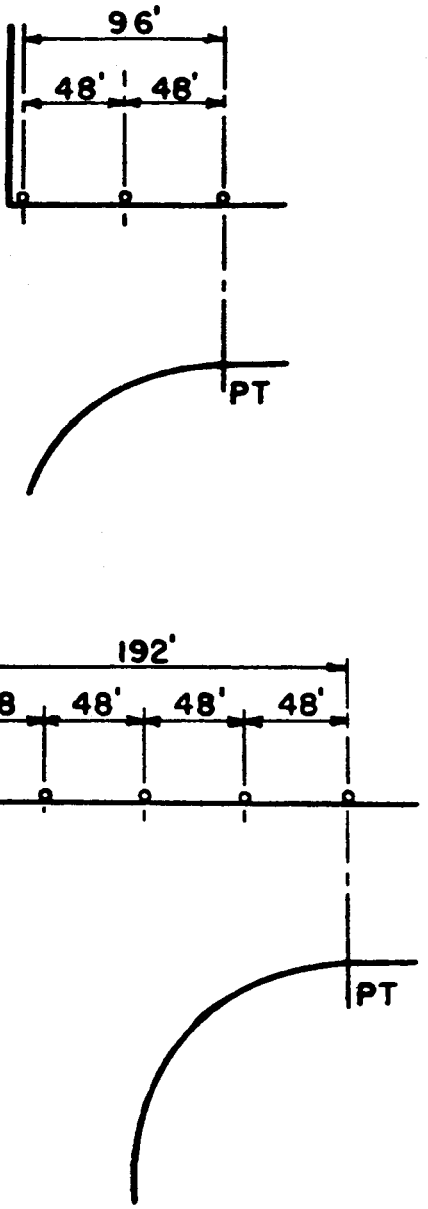
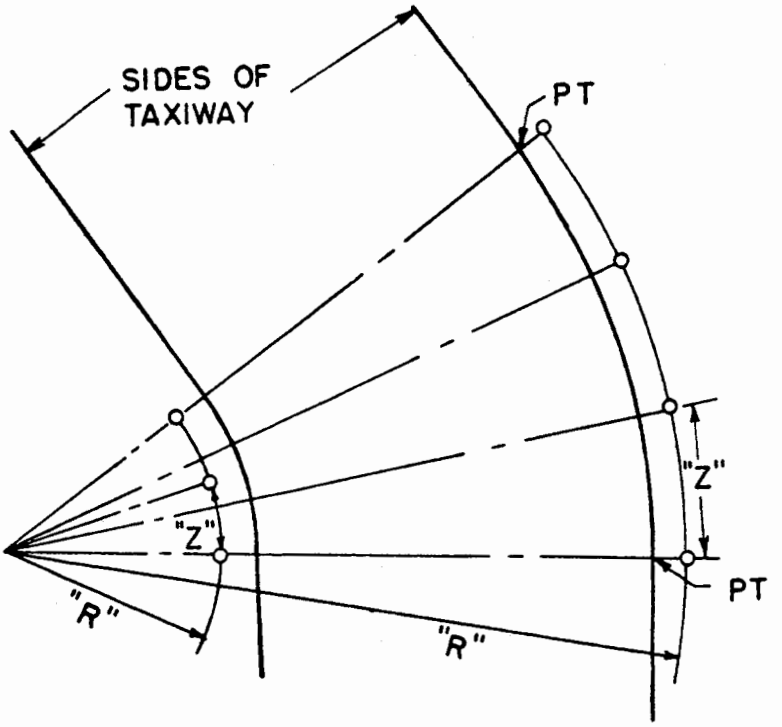


FIGURE 8. TYPICAL SINGLE STRAIGHT TAXIWAY SECTIONS - LESS THAN 200 FEET



RADIUS "R" OF CURVE IN FEET	DIMENSION "Z" IN FEET	RADIUS "R" OF CURVE IN FEET	DIMENSION "Z" IN FEET
15	20	300	80
25	27	400	95
50	35	500	110
75	40	600	130
100	50	700	145
150	55	800	165
200	60	900	185
250	70	1000	200 MAX

NOTES: 1. For radii not listed, determine "Z" spacing by linear interpolation.

2. "Z" is the chord length.

3. Uniformly space lights on curved edges. Do not exceed the values determined from the above table. On curved edges in excess of 30 degrees arc, do not install less than three lights including those at PT's.

FIGURE 9. SPACING OF LIGHTS ON CURVED TAXIWAY EDGES.

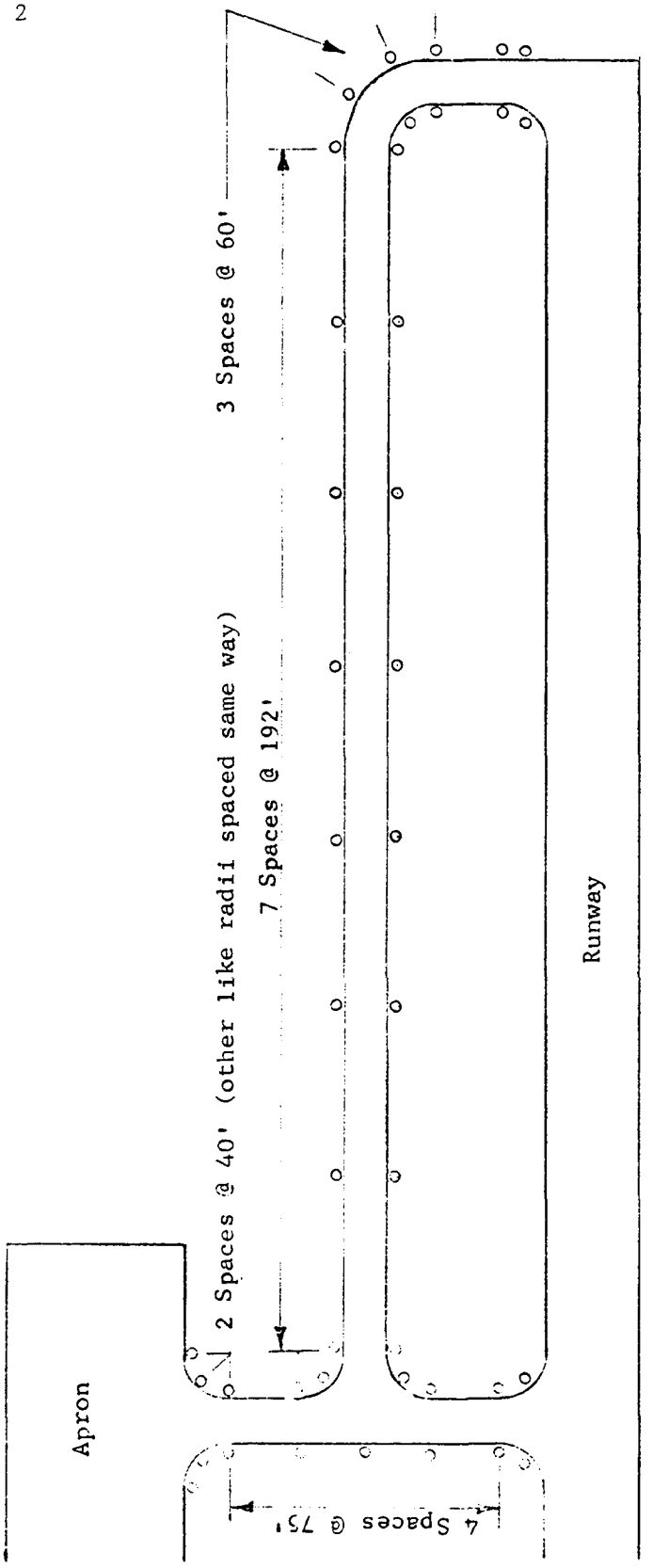


FIGURE 10. TYPICAL TAXIWAY LIGHTING AT GENERAL AVIATION AIRPORT

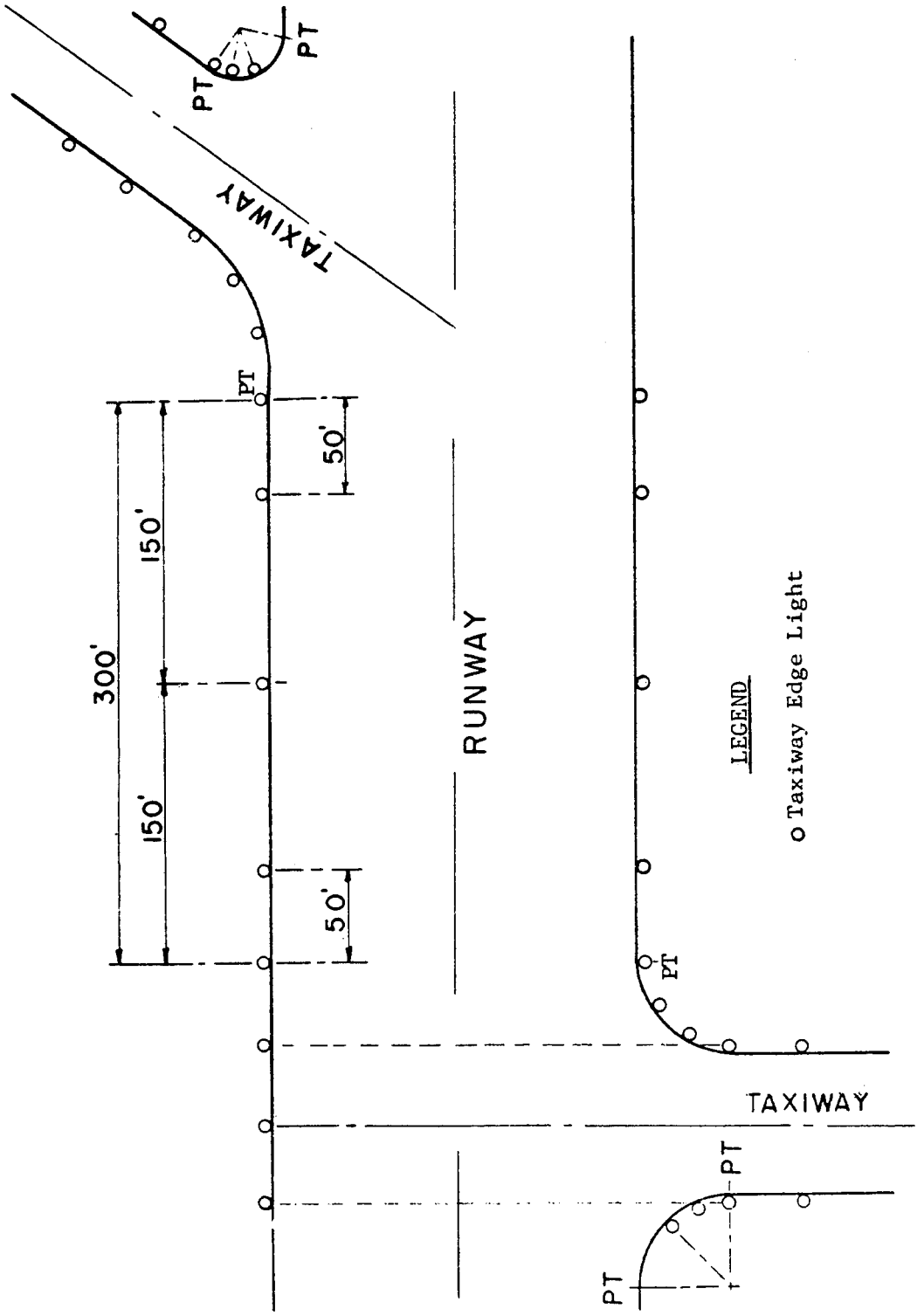


FIGURE 11. TYPICAL EXAMPLE PORTION OF RUNWAY USED AS TAXIWAY

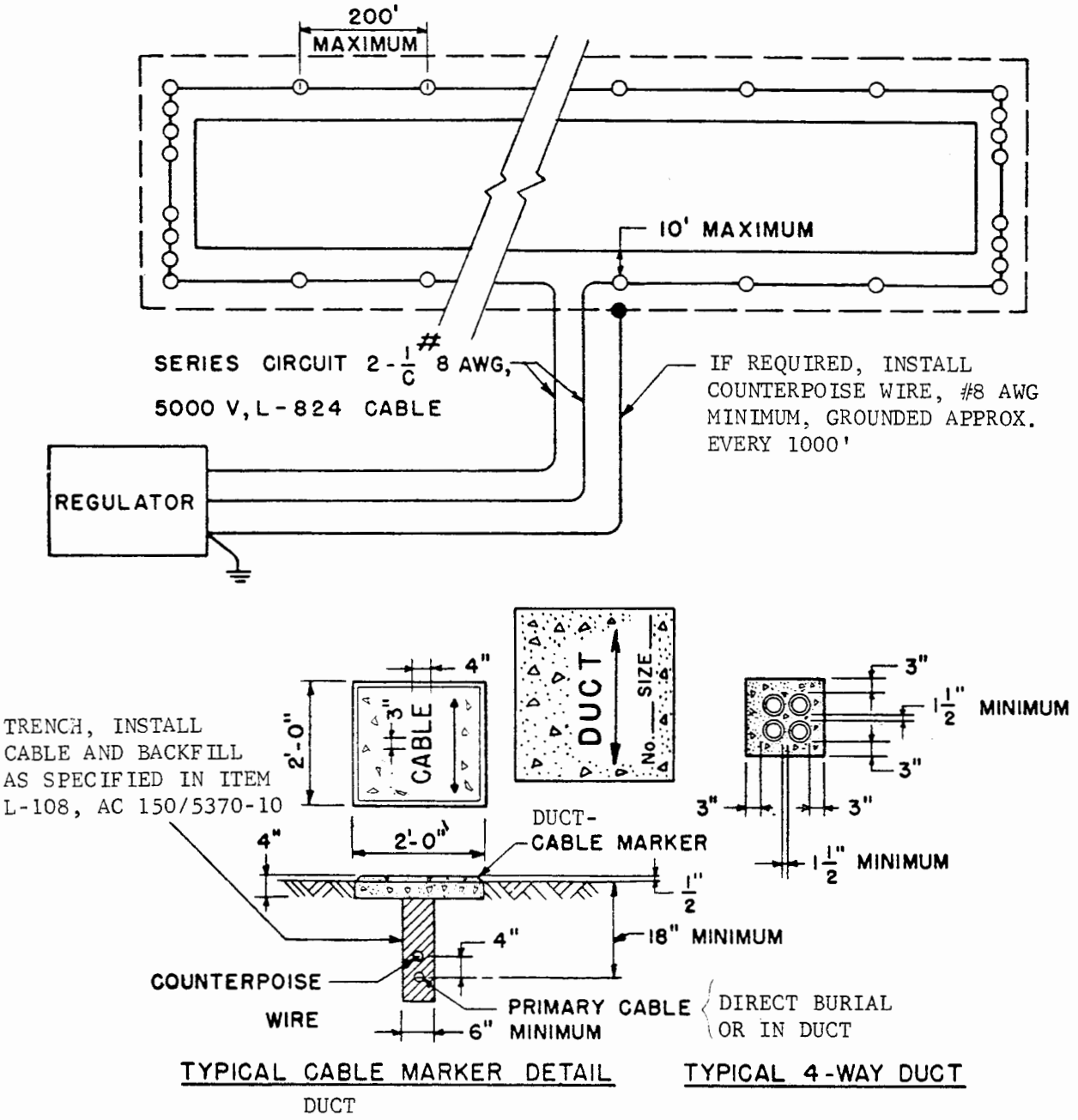
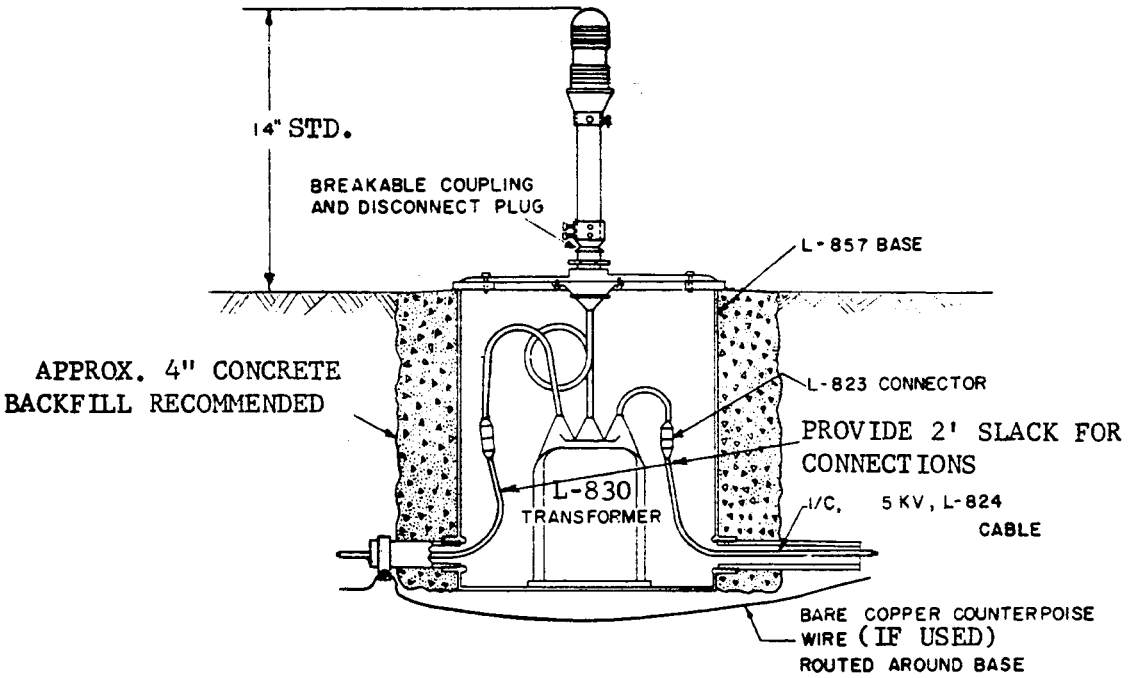
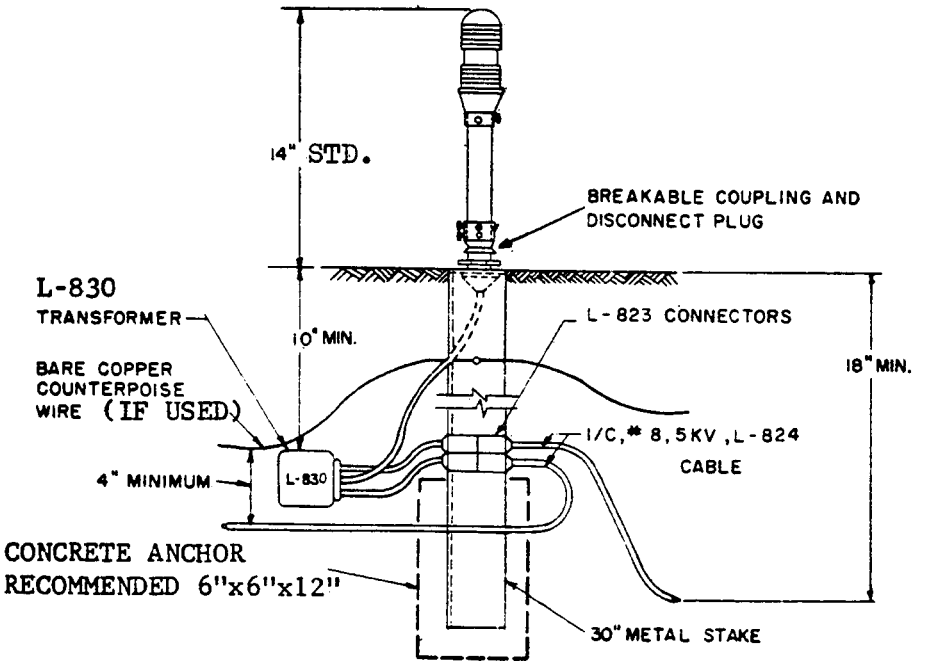


FIGURE 12. TYPICAL SERIES LIGHTING CONFIGURATION

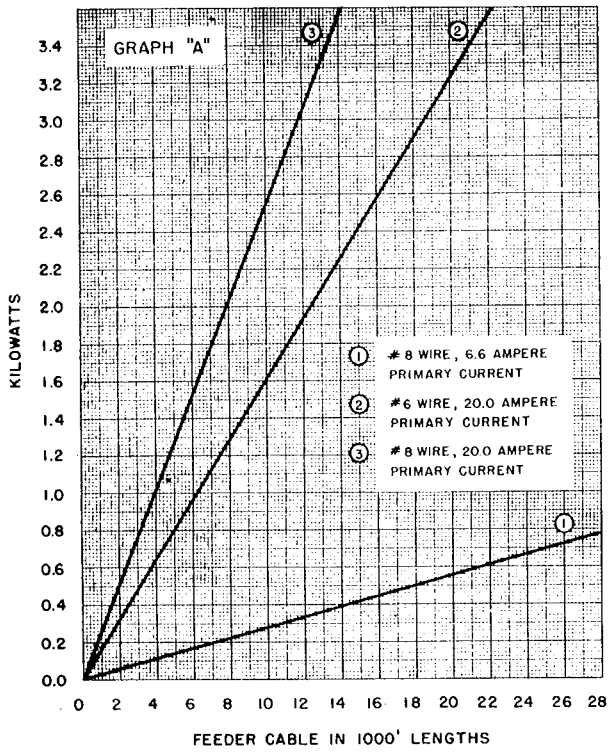


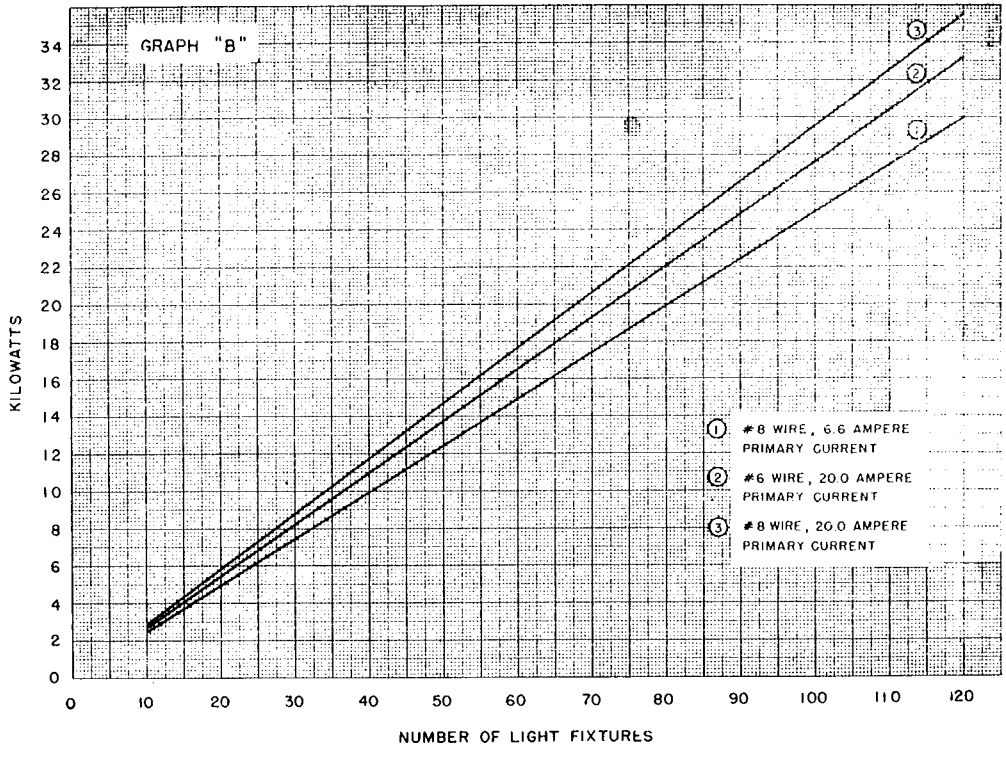
BASE MOUNTED, SERIES CIRCUIT



STAKE MOUNTED, SERIES CIRCUIT

FIGURE 13. SERIES CIRCUIT LIGHT FIXTURE WIRING



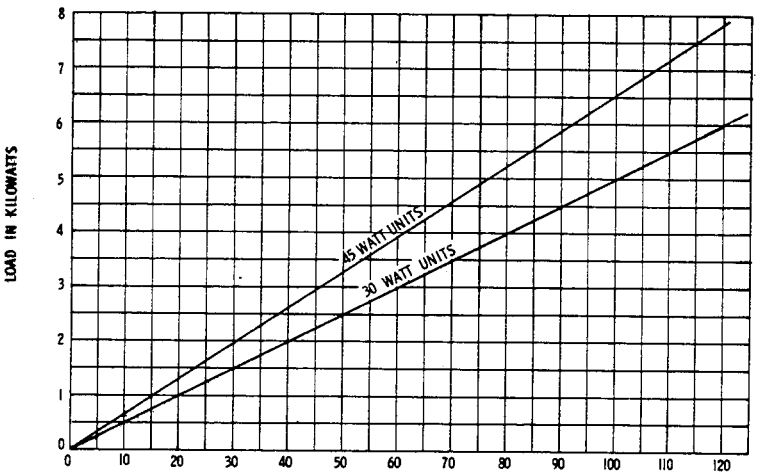


HOW TO DETERMINE TOTAL LOAD

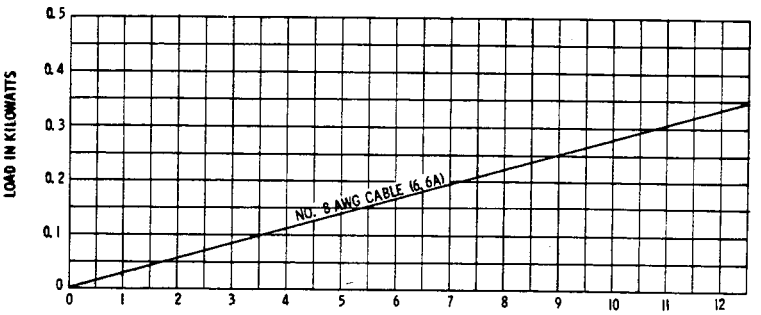
1. Multiply the distance between the vault and the runway by 2 to get the length of the feeder cable. Determine the KW power required for the feeder cable by getting the coordinate point on the applicable kilowatt-feeder cable line of GRAPH "A"
2. Determine KW power required for the number of fixtures to be installed by getting the coordinate point on the applicable kilowatt-number of light fixtures line of GRAPH "B" Curves based on use of 200W lamps.
3. Add kilowatts obtained from GRAPHS "A" and "B" to determine the total KW load required.

FIGURE 14. CURVES FOR ESTIMATING LOADS IN HIGH INTENSITY SERIES CIRCUITS

CURVE (a)



CURVE (b)



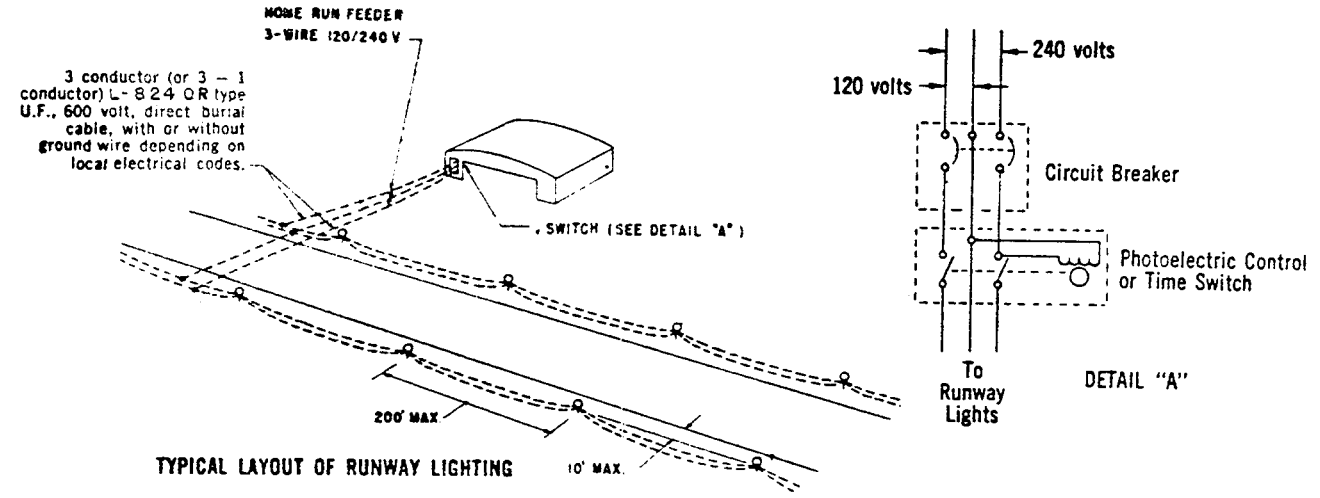
NOTES:

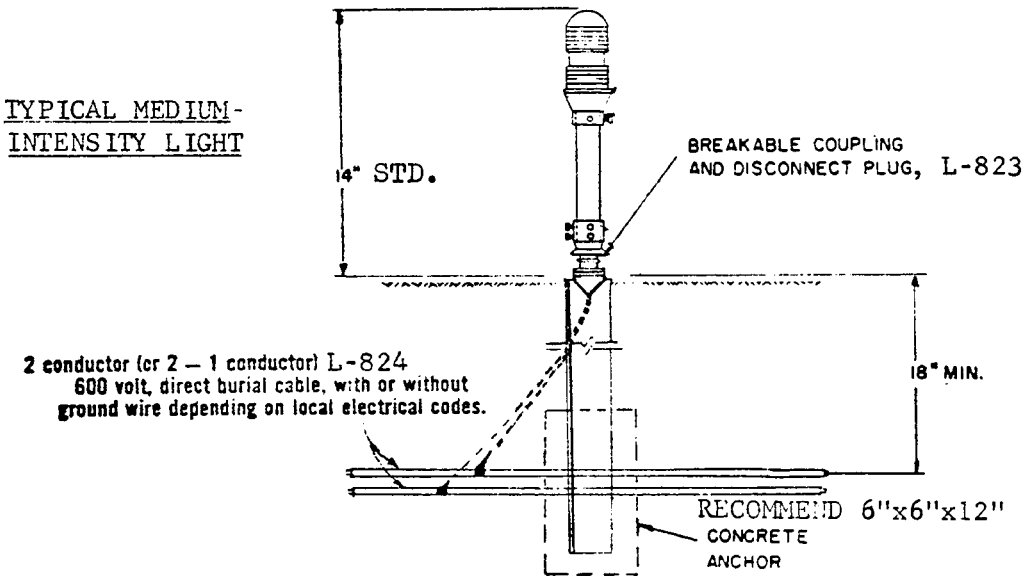
1. Computations based on actual circuit load tests.
2. In Curve (a) figure K. W. load using total number of 45 watt or 30 watt fixtures connected in circuit.
3. Basis for computing unit loads in Curve (a):

30/45 watt transformer with 45 watt lamp	54.7 watts
Cable loss, lamp tolerance, etc.	10.3 watts
Total estimated load per 45 watt unit	65.0 watts
30/45 watt transformer with 30 watt lamp	40.4 watts
Cable loss, lamp tolerance, etc.	9.6 watts
Total estimated load per 30 watt unit	50.0 watts

4. Basis for computing load per 1,000' of No. 8 AWG cable in Curve (b):
   $I^2R = (6.6A)^2 \times 0.6405$ ohms/1,000' = 27.9 watts/1,000'
5. Obtain total K. W. load per runway circuit by adding K. W. loads obtained from Curves (a) and (b).

FIGURE 15. CURVES FOR ESTIMATING KILOWATT LOADS FOR MEDIUM INTENSITY SERIES LIGHTING CIRCUITS





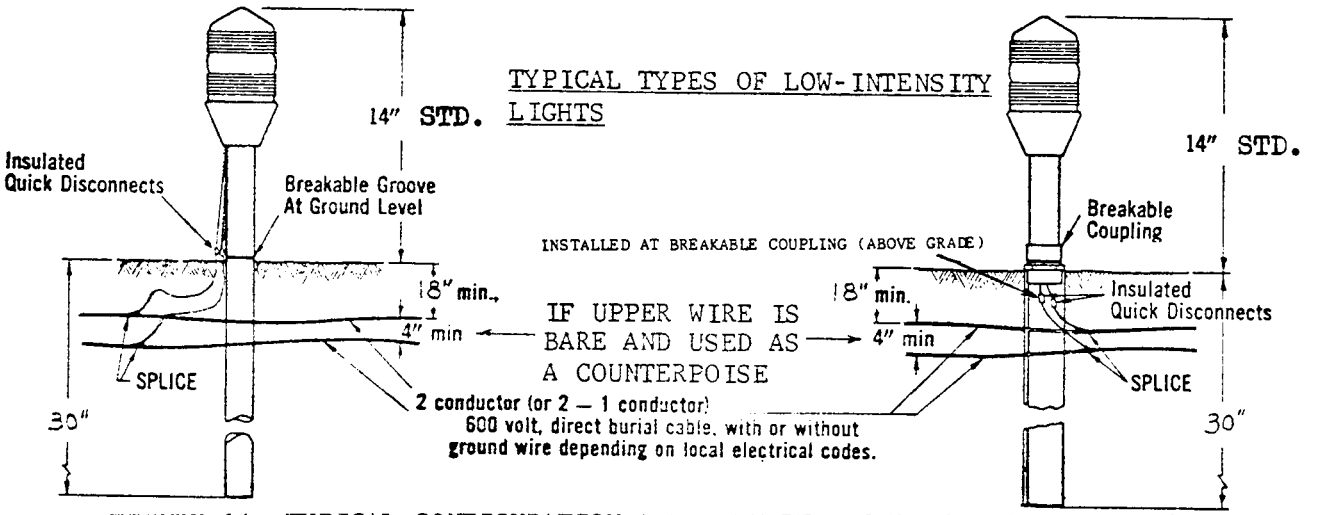


FIGURE 16. TYPICAL CONFIGURATION AND FIXTURE INSTALLATION OF LIGHTS USED IN PARALLEL CIRCUITS

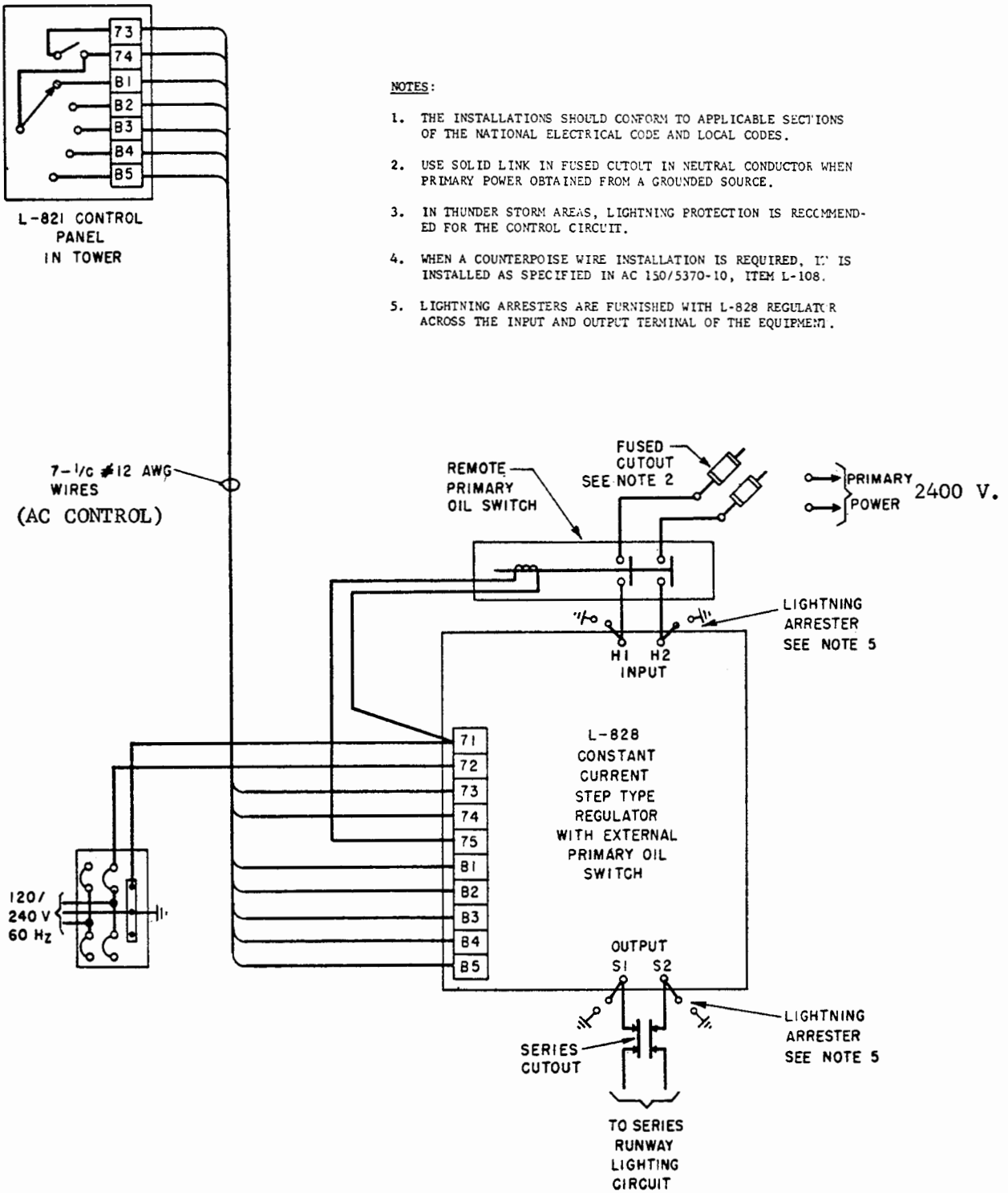


FIGURE 17. TYPICAL HIRL WIRING DIAGRAM UTILIZING L-828 STEP-TYPE REGULATOR WITH EXTERNAL REMOTE PRIMARY OIL SWITCH

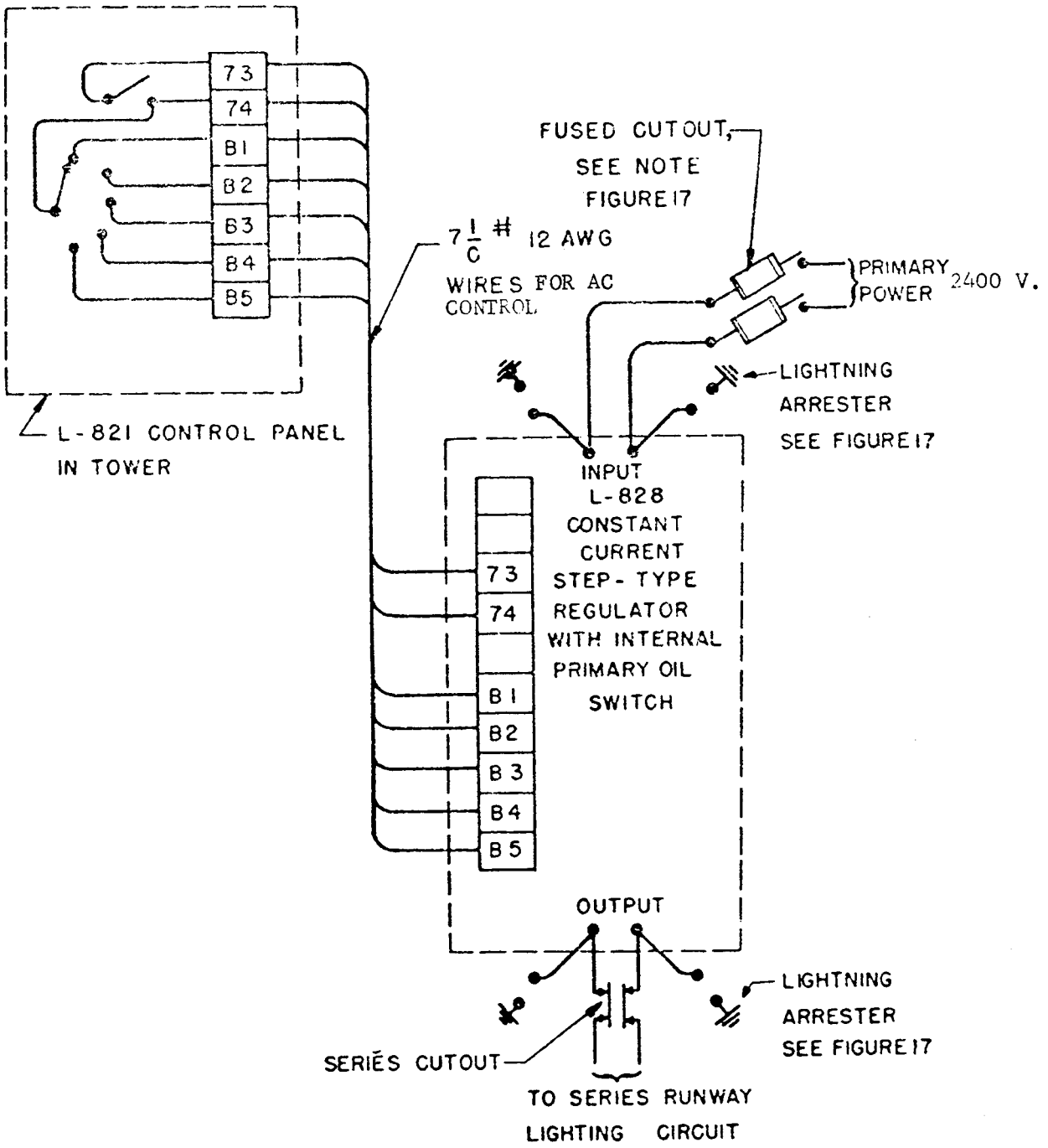


FIGURE 18. TYPICAL HIRL WIRING DIAGRAM UTILIZING L-828 STEP-TYPE REGULATOR WITH INTERNAL CONTROL POWER AND PRIMARY OIL SWITCH

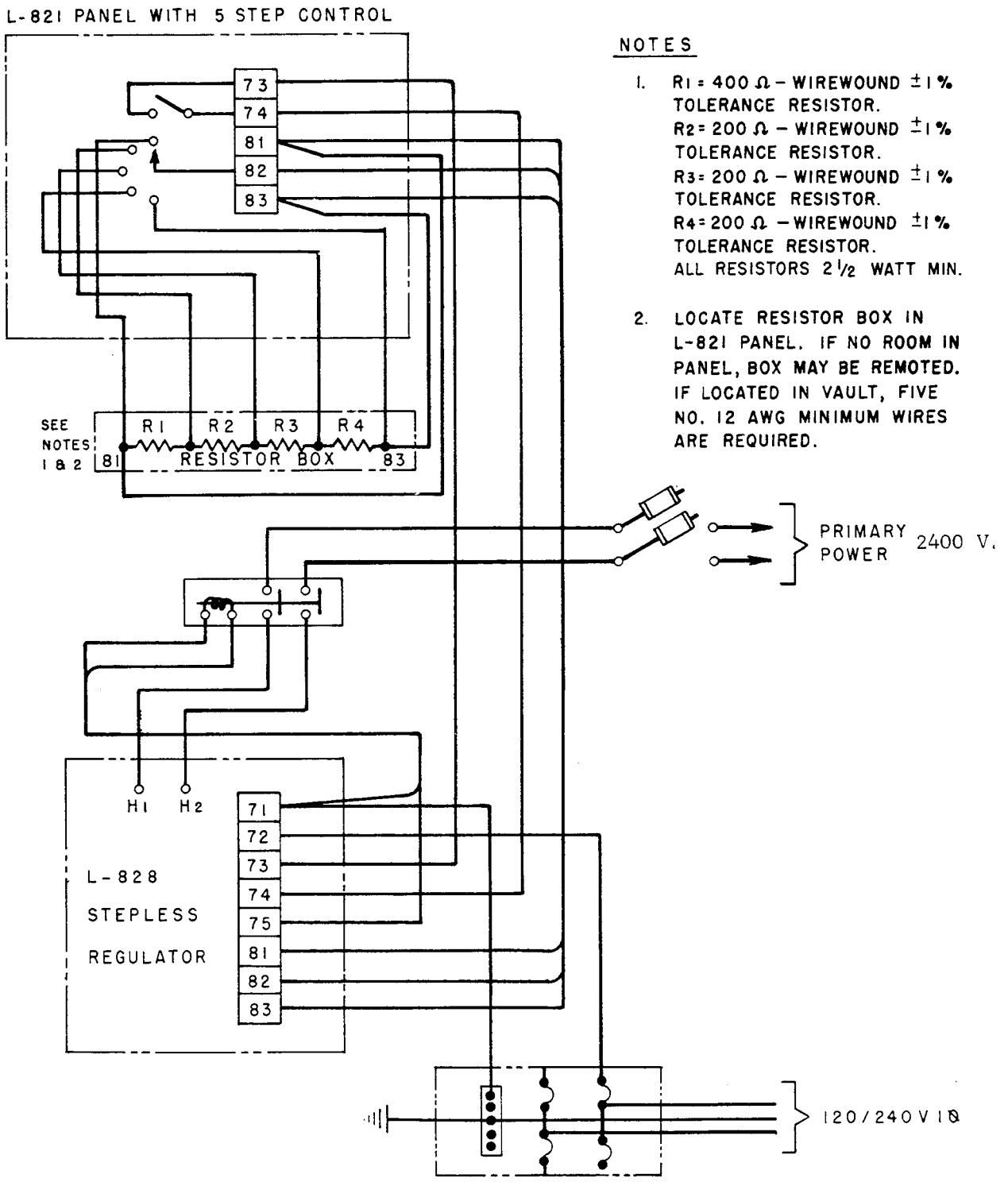
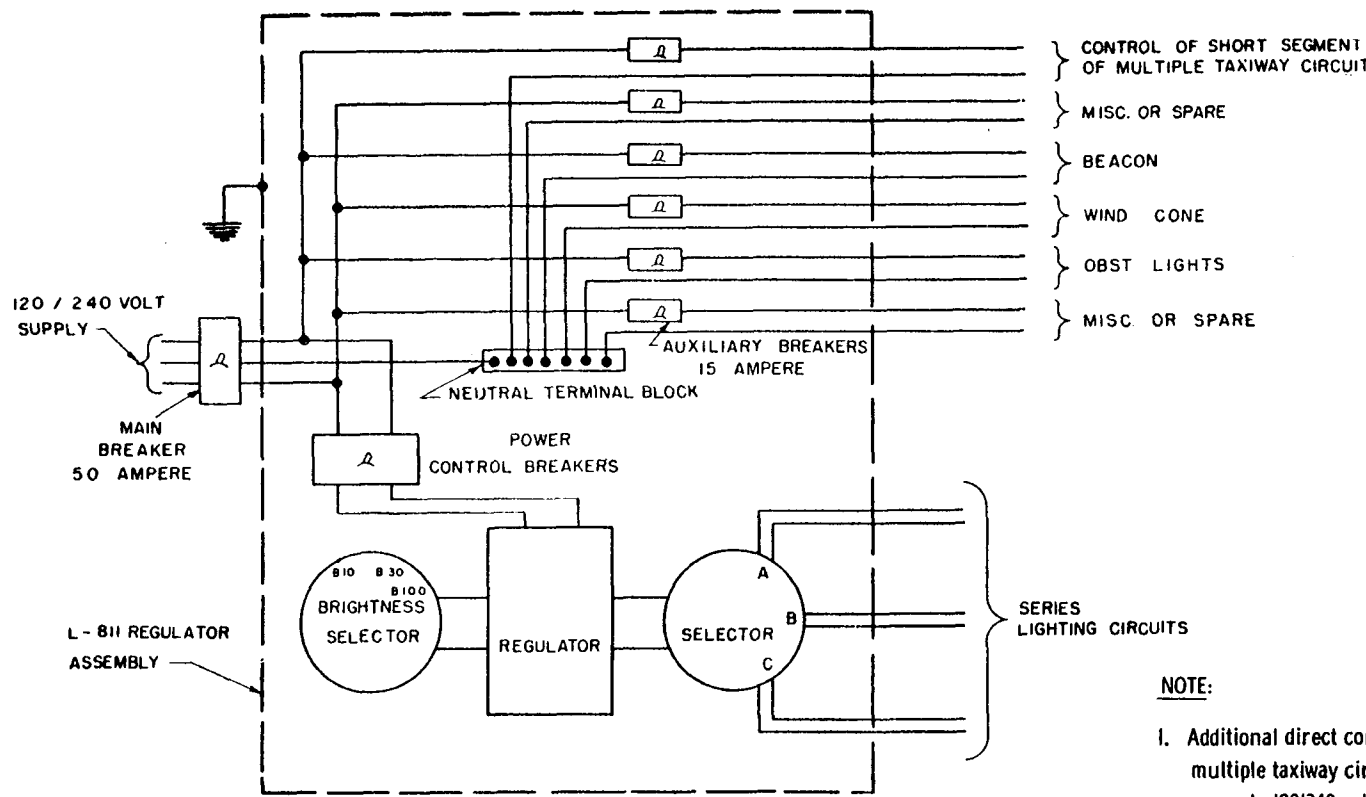


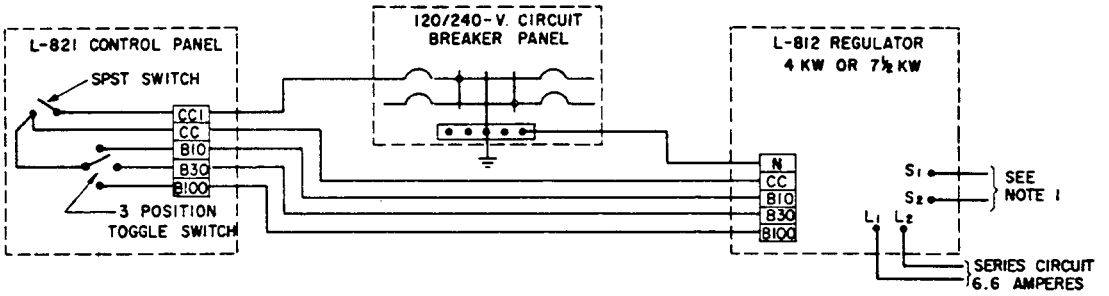
FIGURE 19. TYPICAL DETAILS FOR INTERFACING THE L-828 STEPLESS REGULATOR WITH STEP-TYPE CONTROLS.



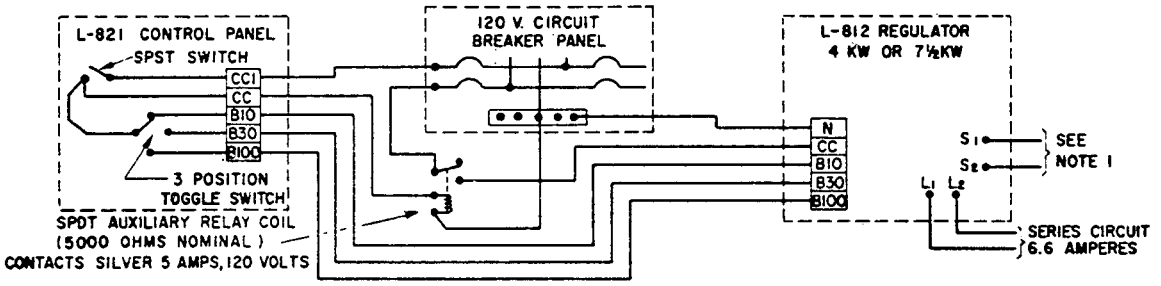
NOTE:

1. Additional direct control of short sections of multiple taxiway circuits may be obtained from separate 120/240 volt circuit breaker distribution panel and/or from a two pole, three - wire, solid neutral safety switch.

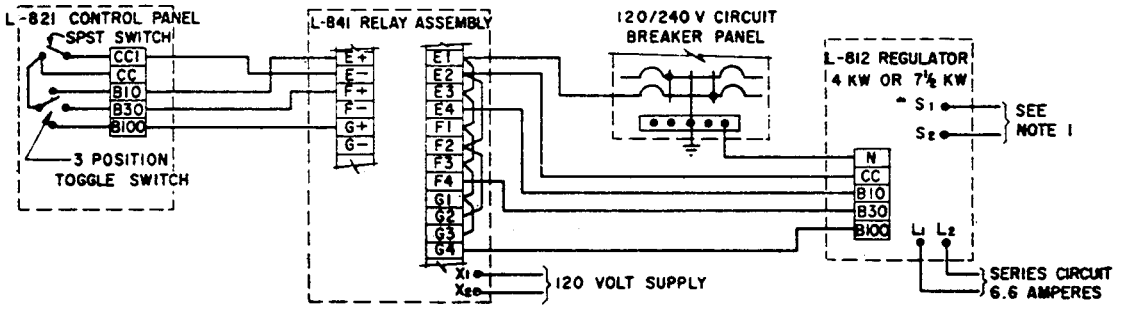
FIGURE 20. TYPICAL DIRECT CONTROLLED REGULATOR



(a) CONTROL 120 VOLTS, 60 Hz



(b) CONTROL 120 VOLTS, 60 Hz UTILIZING AN AUXILIARY RELAY FOR L-812 REGULATOR

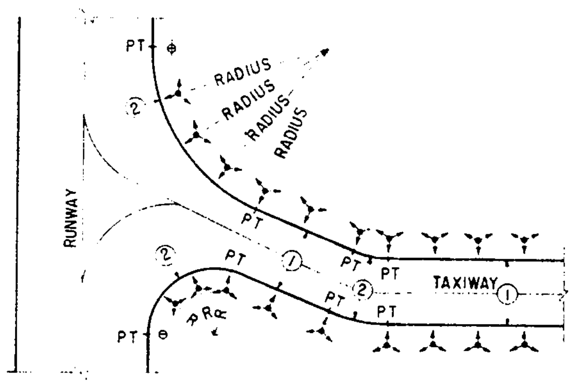


(c) CONTROL 48 VOLTS, DC

NOTES:

1. THE L-812 REGULATOR IS SHIPPED WITH ITS INPUT CONNECTED FOR 240 VOLTS OPERATION. RECORD THE INPUT VOLTAGE AT THE LOCATION THE REGULATOR IS TO BE INSTALLED AND CONNECT THE INPUT TAP SO THAT THE MAXIMUM MEASURED VOLTAGE WILL NOT EXCEED THE REGULATORS TAP RATING.
2. INSTALL THE L-821 PANEL, L-841 PANEL, AND L-812 REGULATOR IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.
3. MAKE THE INSTALLATION IN ACCORDANCE WITH THE NATIONAL AND LOCAL CODE REQUIREMENTS.

FIGURE 21. TYPICAL REMOTE CONTROLLED REGULATORS



ORIENTATION OF TAXIWAY LIGHTS USING MASKED LAMPS

LEGEND

① Runway light fixture

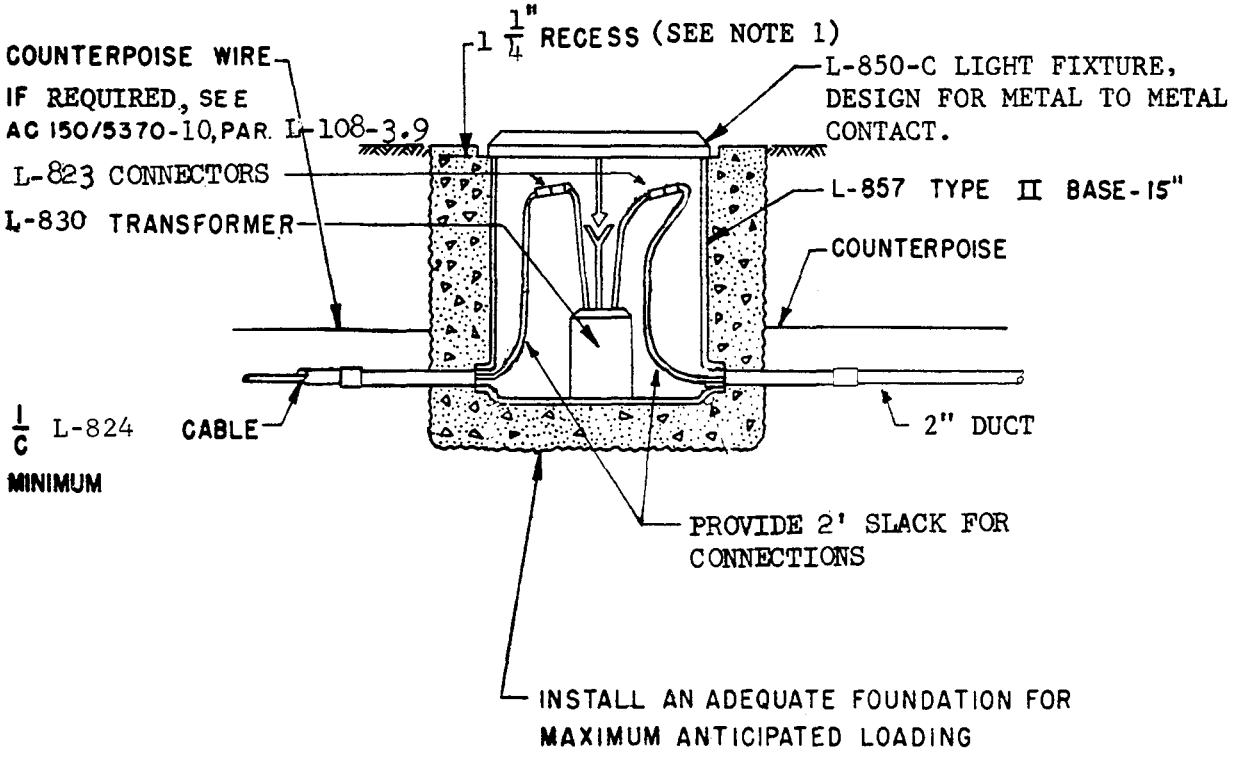
PT Point of tangency

Taxiway light fixture

NOTES

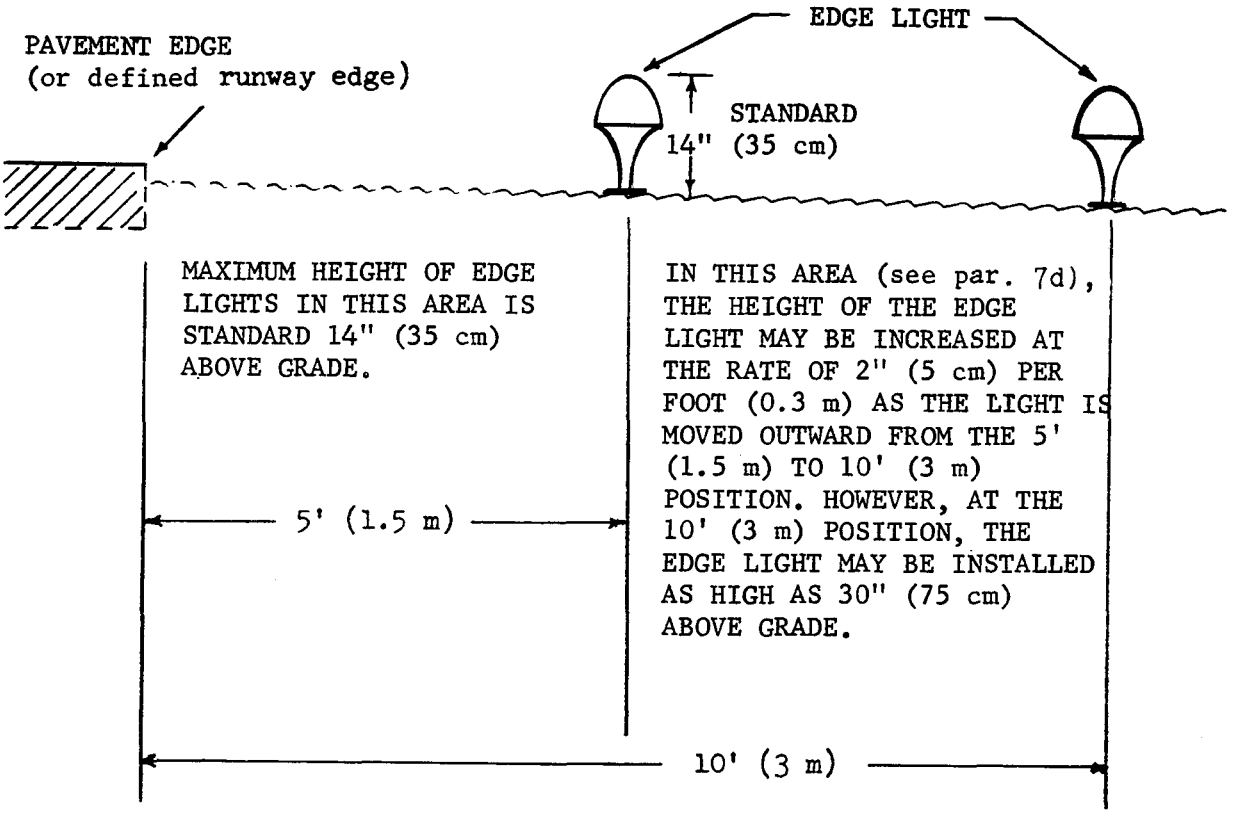
1. Taxiway light fixtures on straight sections of taxiways should be oriented so the center of the light pattern will be perpendicular to the edge of the taxiway.
2. Taxiway light fixtures on curved sections of taxiways should be oriented so the center of the light pattern will fall on the extended radius of curve through the fixture location. See figure 9 for spacing of lights on curved edges and for straight sections, see figures 5,6,7 & 8.

FIGURE 22. ORIENTATION OF TAXIWAY LIGHTS UTILIZING MASKED LAMPS.



NOTE 1. IF INSTALLATION IS IN BITUMINOUS PAVEMENT, LEAVE CONCRETE BACKFILL 3 - 4 INCHES LOW FOR BACKFILL WITH BITUMINOUS MATERIAL. ALTERNATELY USE A TWO SECTION BASE WITH THE SECOND SECTION INSTALLED AFTER THE FINISH BITUMINOUS SURFACE HAS BEEN CORED.

FIGURE 23. TYPICAL INSTALLATION OF L-850-C EDGE LIGHT



NOTE: WHEN LIGHTS ARE ELEVATED ABOVE STANDARD HEIGHT, A MINIMUM CLEARANCE OF 6" (15 cm) MUST BE MAINTAINED BETWEEN THE LIGHT AND ANY OVERHANGING PART OF AN AIRCRAFT EXPECTED TO USE THE RUNWAY OR TAXIWAY WHEN ITS MAIN LANDING GEAR IS LOCATED AT THE EDGE OF THE PAVEMENT.

FIGURE 24. ADJUSTMENT OF EDGE LIGHT ELEVATION DUE TO SNOW CONDITIONS

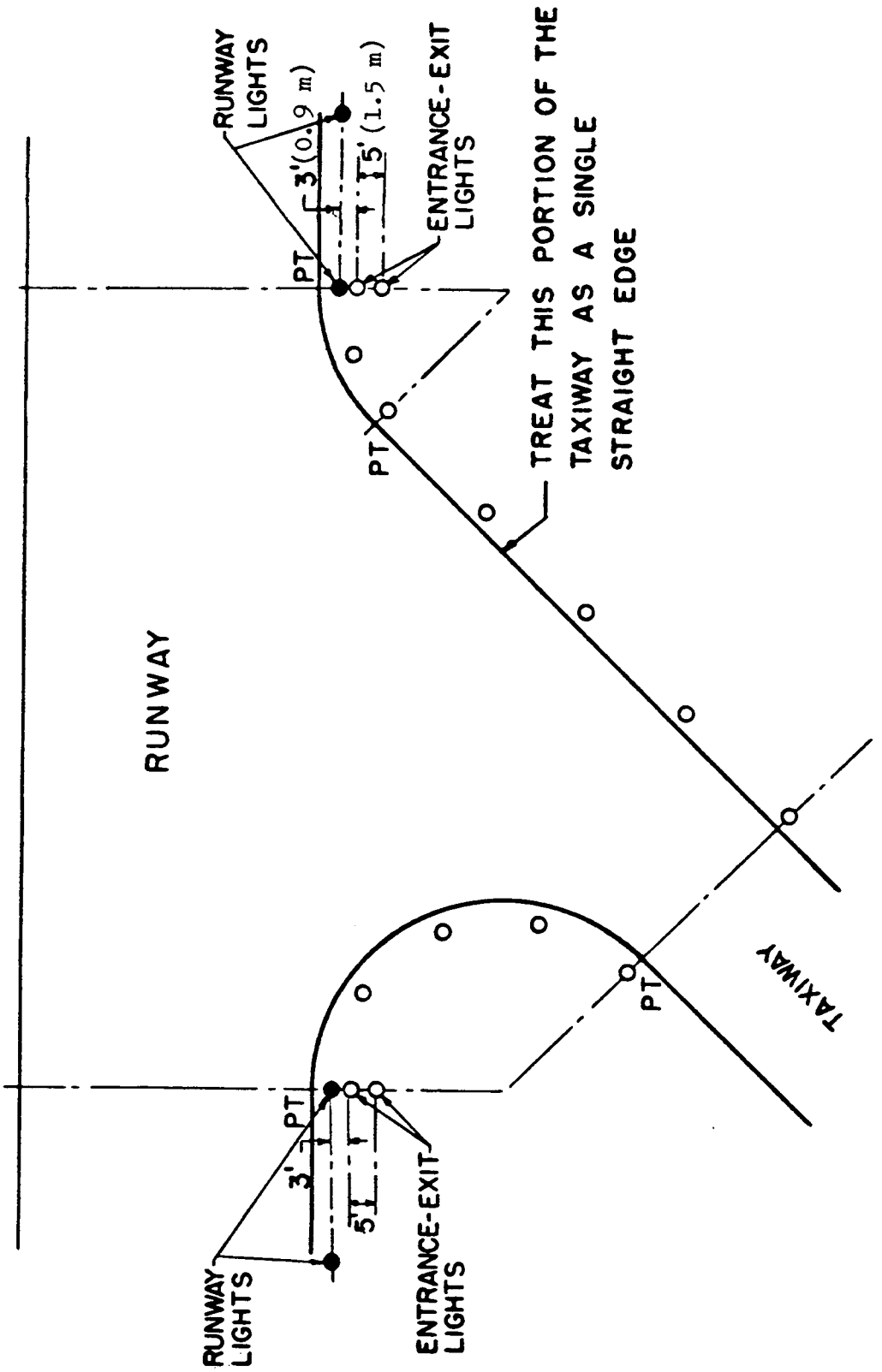


FIGURE 25. LOCATION OF ENTRANCE-EXIT LIGHTS (in lieu of guidance signs)

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